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To Dr. J.K. King.

With the Compliments
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A STUDY OF THE BLADDER

DURING PARTURITION

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DURING PARTURITION

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TO

PROFESSOR ALEXANDER RUSSELL SIMPSON

THESE PAGES ARE DEDICATED.

THE following pages represent the outcome of observations made during various terms of duty at the Maternity Hospital here. They were communicated in the form of papers to the Edinburgh Obstetrical Society, and embody some results which I hope may justify me in presenting them in a collective form.

J. H. C.

25 CHARLOTTE SQUARE,
December 15, 1883.

A
STUDY OF THE BLADDER
DURING PARTURITION.

THE object of the present inquiry is to ascertain the extent and manner in which the bladder and its contents are influenced by parturient efforts. The means taken to ascertain this will be hereafter described.

Before reaching the main issue, several questions naturally fall to be discussed. It is therefore convenient at the outset to arrange the study under the following divisions :—

1. The question of uterine pressure during parturition.
2. The topographical anatomy of the bladder during pregnancy and parturition, and some clinical observations connected with it.
3. Experiments to estimate bladder pressure during labour ; its amount, distribution, and cause.
4. The results arrived at.

The estimation of uterine pressure—that is, of the power of the uterine contraction—is a question upon which very considerable attention has been bestowed by Poppel, Haughton, Duncan, Joulin, Schatz, Ribemont, Poullet, and others.

It forms no part of my present task to enter in detail into this question, yet it is essential that these investigations should be shortly stated, in order that two points may be established—

1st, The amount of force exerted during parturition.

2d, How that force is expended or distributed.

I. THE AMOUNT OF FORCE.

Different methods have been adopted by different observers in order to arrive at a solution of this problem.

Poppel, Matthews Duncan, and Ribemont, have estimated the force necessary to rupture the membranes, and have considered that force as representing approximately the intensity of the uterine contractions. Poppel found that on an average a force of 4.248 kilogrammes (9.4 lbs.) was required to rupture a surface of membranes 5. centimetres (1.9 inch.) in diameter.

The lowest number was 1.301 kilogrammes (= 2.8 lbs.); the highest number was 6.002 kilogrammes (= 13.2 lbs.) He made the same researches upon a surface of 10 centimetres (= 3.93 inches) in diameter, and found—

The highest figure	9.876	kilogrammes	(= 21.7 lbs.)
The lowest „	2.134	„	(= 4.6 lbs.)
Average „	6.162	„	(= 13.4 lbs.)

The conclusion he draws from these calculations is, that in normal deliveries a force from 2 kilogrammes (= 4.4 lbs.) to 9.5 kilogrammes (= 20.9 lbs.) is required to expel the fœtus.

Matthews Duncan, judging by his own experiments conducted in the same line as those of Poppel, enunciates "the almost certain conclusion that a great mass of *easy*, and not merely the *easiest*, labours are terminated by a power little in excess of that required to rupture the bag of membranes. The strongest membrane found in this experiment indicated, by the pressure required to burst it, an extruding force of 37½ lbs.

"We may therefore, I think, safely venture to assert as a highly probable conclusion, that the great majority of labours are completed by a propelling force not exceeding 40 lbs.

"If we regard the figure of 4 lbs., given by Poppel, as equal to the power exerted in the easiest labour he has observed, or the corresponding figure of 6 lbs. according to my calculations, and keep in mind that the average weight of the adult fœtus exceeds either of these weights, we are led to the conclusion that in the easiest labours almost no resistance is encountered by the child—that it glides into the world propelled by the smallest force capable of doing so."

Duncan, in an essay on the extreme power of labour, further states :—

"Having had extensive and varied experience in the use of the forceps in difficult labours, and having also made some rough experiments with the dynamometer to ascertain the power I have applied by the instrument, I regard M. Joulin's estimate of a hundredweight as the maximum force of the parturient function as too high.

"I do not deny that, in very rare cases, such a force may possibly be produced; but I am sure that it is nearer the truth to estimate the maximum expulsive power of labour—including with the uterine contractions the assistant expulsive efforts—as not exceeding 80 lbs."

Ribemont made his experiments with great care, and found that over an orifice of 10 centimetres the membranes ruptured with a mean pressure of 10.3 kilogrammes (= 22.8 lbs.)

The maximum of resistance, 11.179 kilogrammes (= 24.4 lbs.) The amnios alone resisted up to 7.988 kilogrammes (= 17.3 lbs.); whilst the chorion and decidua, without the amnios, ruptured under a pressure of 5.66 kilogrammes (= 12.3 lbs.)

Joulin, by means of forceps to which he attached a dynamometer, found the maximum force about 104 lbs.

Schatz has endeavoured to estimate the pressure exerted during labour in a different way. He used the following apparatus, which he denominates a Tokodynamometer. This consists of a little balloon of caoutchouc filled with water, which is introduced into the uterus between the fœtus and the uterine walls, and which by tubes of caoutchouc is put in communication with a manometer.

This has attached to it a corresponding register, which traces on paper curves similar to sphygmographic tracings, indicating the variations to which the balloon is subject in the uterus under the influence of expulsive forces.

I embrace this opportunity of pointing out what appears to me an obvious fallacy in this method of investigation, and which I refer to more fully in my calculations as to bladder pressure.

It consists in the fact, that the force was conveyed through an apparatus of elastic material. Before any absolute deductions as to the force exerted by the uterus can be made from the movements of the mercury, it would be necessary to add the force lost on the elastic walls of the indiarubber bag. This has not been done; indeed it is difficult to see how it could be done. This omission vitiates the entire results.

He found that the pressure exerted by the uterine and abdominal muscles at the end of labour varied from 80 to 250 millimetres; that is, 3.2 to 10 inches of mercurial pressure.

According to him the expulsion of the fœtus required a force of from 8.5 kilogrammes to 27.5 kilogrammes (*i.e.* 17½ lbs. to 60½ lbs.)

Poullet of Lyons attempted to settle the question of uterine pressure by means of an instrument which he called the Tokograph. His observations were conducted by means of two balls of caoutchouc, one of which was inserted into the rectum and the other into the uterus. He thus showed, as he supposed, the entire expulsive force employed in parturition. On the one hand, the balloon in the uterus showed the expulsive power of this organ, while, on the other hand, the balloon in the rectum showed the expulsive force of the abdominal walls. I need not add that to each of these balls were attached tubes, each of which was connected with a column of mercury and a registered scale. His results are open to the same objection as Schatz's; they are very uncertain, and need not be recorded in full here. They are to be found in the *Bulletin de la Societé de Chirurgie*, 1879, p. 8.

The Rev. Samuel Haughton approached the subject from an entirely different point of view. Studying first the force of the uterine muscle, he finds the mean weight of this muscle, derived from Heschl, Montgomery, and Levret, to be 1.56 lbs., the mean thickness of the muscular wall to 0.1519 inch, and the tensile strain of uterine wall per inch to be 15.577 lbs.; and from these data he concludes that the maximum hydrostatic pressure produced by uterine contraction is 3.4 lbs. on the square inch.

Then citing the experiments of Duncan on the pressure necessary to rupture the membranes, who found the greatest pressure was 3.1 lbs. and the least 0.26 lb., giving a mean of 1.2 lb., and combining this experimental result with his calculations, he concludes that the uterine muscles are capable of rupturing the membranes in every case, and possess in general nearly the requisite power to complete labour. The extreme force of uterine contraction he estimates produces, or rather is equivalent to, a pressure of 54.1 lbs., differing, it will be observed, very considerably from Joulin and Duncan.

Haughton then discusses the force brought in by the abdominal muscles, which are four in number, viz.—rectus abdominis, obliquus externus, obliquus internus, and transversalis.

He found by experiment upon three young men, multiplying the curvature into the tension of the abdominal muscles at the navel, that the result was an expulsive force of 32.926 lbs. on the square inch, available to assist the uterus in completing the second stage of labour.

Adding the combined forces we get—

Involuntary muscle	54.10 lbs.
Voluntary muscle	523.65 „
Total	577.75 lbs. av.

Between 577.75 lbs. of Haughton and 80 lbs. of Duncan there is obviously a marked difference, and it comes to be an interesting question to ascertain how this remark-

able diversity has arisen. As I have just shown, the two observers approach the subject from different standpoints. The one calculates from the data I have mentioned—the entire strength of the uterine and abdominal wall contraction, the other by observations on the body being expelled, calculating the force expended on it.

Is it possible then to explain this discrepancy? I think it is. In the explanation I am brought directly to the subject of my inquiry.

First, then, of the three elements entering into Haughton's calculation, one, viz., the tensile strain of the uterine muscle, must be taken with very great reservation. The calculation is on the "breaking strain." Such may be the breaking strain, but then such strain is not a fair calculation. Take an analogy from engineering—a square inch of good iron will rupture on the application of a force of 50,000 lbs., but in actual work 10,000 lbs. would only be allowed per square inch, so giving a factor of safety of 5. It is scarcely to be supposed that nature will work up to the "breaking strain." That nature does work up to the "breaking strain" is of course occasionally a fact. This is shown in cases of spontaneous uterine rupture. Even here, however, the rupture does not take place in the tissue tested by Haughton, but at the weakest part of the organ—the union of cervix and body, and only after the nutrition of the organ has been interfered with by pressure on the blood-vessels. What factor of safety nature allows it is, I presume, impossible to say. Engineers allow 10 as a factor of safety in a dynamic load and 5 as a factor in a static load. It must at least be very obvious that in the majority of labours the work done must be at a strain very much within the breaking strain, and therefore a very considerable deduction must be made on this head alone from Haughton's figures. But I will not press this point to its utmost limits, for although Duncan has shown that Haughton has over-estimated the expulsive power of the uterus and abdominal muscles in ordinary labour, and ridiculed his statement that "on an emergency somewhat more than a quarter of a ton of pressure can be brought to bear on a refractory child which refuses to come into the world in the usual manner," yet it is not impossible that Haughton's figures may approximately describe the "breaking strain." It must be kept in view that even in cases of rupture of the uterus the rupture does not accurately represent the breaking strain of the healthy uterine muscle.

My point is simply this, allowing a factor of safety in Haughton's experiments, it brings his figures, in proportion as the factor of safety is large or small, very considerably down. But, secondly (and this is a point to which, so far as I know, no allusion has been made, and which to some extent goes to reconcile the great discrepancy in the results of Haughton on the one hand,

and Duncan, Joulin, and others, on the other), while Haughton, from the data I have alluded to, calculates the entire pressure of abdominal walls and uterus, Duncan and others estimate only the pressure on the fœtal head. It is obvious, therefore, that from Haughton's total sum there falls to be deducted the force lost on the hard and soft pelvis. In other words, allowing Duncan's 80 lbs. as correct, and allowing a large factor of safety in Haughton's figures, the difference between the two may amount to the sum of the force lost on the girdle of contact, wherever and whatever that for the time may happen to be. That such pressure does exist upon part of the contents of the pelvis, and that to a very considerable extent, the sequel of this inquiry will show.

If it is possible to calculate the pressure which is to be subtracted from the entire uterine pressure lost on the bladder during parturition (see note B), further experiments may be made to ascertain approximately the amount of pressure lost upon other portions of the pelvis and its contents. It is only thus that a true estimate of uterine force can be obtained, for while Duncan is no doubt near the truth when he estimates the amount of pressure at 80 lbs. in laborious and 40 lbs. in easy labours, yet it must be very clearly kept in view that this is no estimate of the entire amount of uterine force exerted in any given labour, but merely the pressure exerted on the head.

The pressure dissipated on the passages is entirely left out of the calculation. This brings me directly to the task I have set myself, viz., to ascertain the amount and distribution of the pressure exerted on the bladder during parturition.

RELATION OF THE BLADDER.

Following out the plan laid down at the commencement, it becomes my duty to examine into the relation and condition of the female bladder. It would be foreign to the present subject to enter into a lengthy description of this viscus. I wish to confine my remarks entirely to the relations of the bladder so far as they affect the inquiry on hand.

(A.) *In the Unimpregnated Condition.*

It is necessary to state generally that the female bladder lies lower in the pelvis than the male; placed between the pubes anteriorly, the uterus posteriorly, the vagina and cervix inferiorly, and the intestine superiorly. When empty it lies forward on the symphysis, slightly overtopping it, and occupies but little space.

When partially or entirely filled, it rises above the pubes to a varying extent. It is consequently a pelvic or pelvi-abdominal organ, according to its repletion.

Beyond these general facts there are some points to which attention must be specially drawn, and which are characteristic of the female bladder.

1st, It is flatter in women than in men. I now speak of the moderately-distended organ. In man it is ovoid. Its lower fundus admits of greater distension laterally in women, owing to the obvious arrangement of the vagina and pelvic organs generally. A glance at the accompanying diagrams will show this. These diagrams are specially valuable as showing this fact, because they were drawn with a totally different object, and only incidentally show the point in question. They are taken from Pettigrew's monograph on the muscular fibres of the bladder, and were sketched to show their arrangement. In these diagrams this flattening and broadening of the

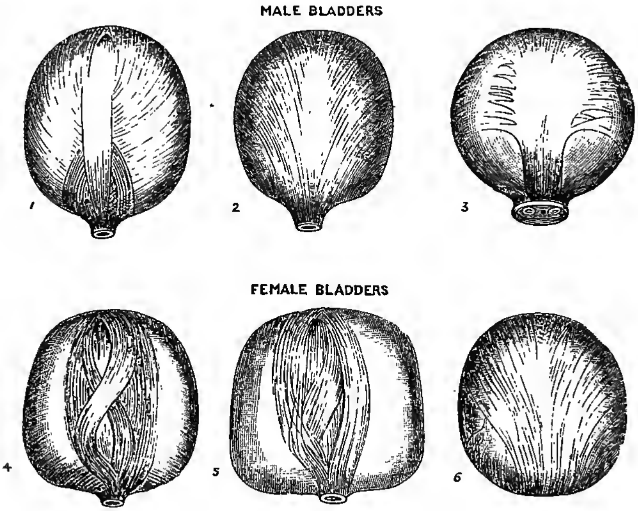

Fig. 1.—Comparison of male and female bladders as to flattening (Pettigrew).

female bladder, as compared with the male, comes out very clearly defined.

The fact is noteworthy that this flattening and broadening of the bladder is more marked in multiparous women. In them the whole organ has more breadth than height.

This was noted by Haller. It may be accepted as a fact. Indeed it would *à priori* seem to be natural. For if the normal bladder is originally broad and flat, it is but to be expected that, in repeated pregnancies, the weight of the uterus pressing on it and interfering with its expansion upwards, will tend to make it expand laterally. With the repeated occurrence of pregnancy this lateral expansion will become more and more marked. To the clinical observer nothing is better recognised than this flat condition of the bladder in multiparæ. In making a bi-manual examination, the difficulty of mapping out the broad moderately-distended bladder admits of ready demonstration. The explanation just offered seems a feasible one. Barkow, however, doubts its value. He has found that this want of pyramidal form, or flattening, occurs in men in whom, of course, no such cause will account for it. In some multiparous women he has not found this condition.

He mentions one case specially of the bladder of a woman who died of phthisis æt. 41, after bearing *ten* children. In this case he expected to find broadening and shortening, but he found an oval bladder.

Barkow offers a different explanation. He attributes this special form less to the effects of pressure of the pregnant uterus, than to the movements of the uterus and its annexa, which lie behind the bladder. These drag on the bladder, bring about contraction of the organ, and cause shortening. Barkow simply mentions the fact. It seems to me that (*a*) the freer movements of the parous uterus, (*b*) its greater weight, (*c*) its lower situation, (*d*) the frequency of displacement both of the uterus and vaginal walls, all seem to give great weight to his suggestion. It is scarcely possible to exclude the pregnant uterus as a factor in the production of this shape. Both influences no doubt are concerned in imparting this shape to the organ. Whichever preponderate, the fact remains that the female bladder is markedly flat; and that in parous women the preponderance of breadth over height is remarkable.

2d, The female bladder is marked by lateral asymmetry. The accompanying diagrams, taken from bladders depicted by Barkow, show this.

The following observations are from that author:—

Out of 35 bladders of adult women—
        In 10 asymmetry was minor,
        In 21 ,, ,, major.
Out of the 35 only 4 were completely symmetrical.

I wish to draw special attention to the fact that the asymmetry is much more marked on the *right* than on the left—

Right . . .	18
Left . . .	8

Again, this asymmetry, though characteristic of the female bladder generally, is so constantly present in the bladder of parous women, that it may be regarded as the normal condition.

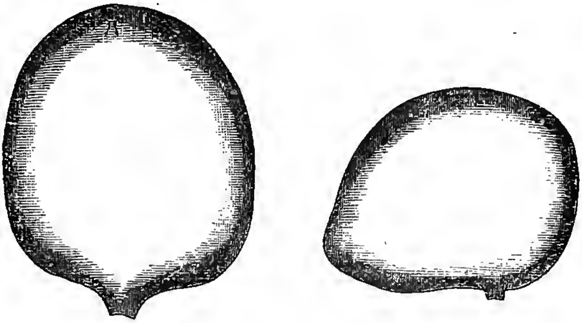

Fig. 2.—Asymmetry of bladder (Barkow).

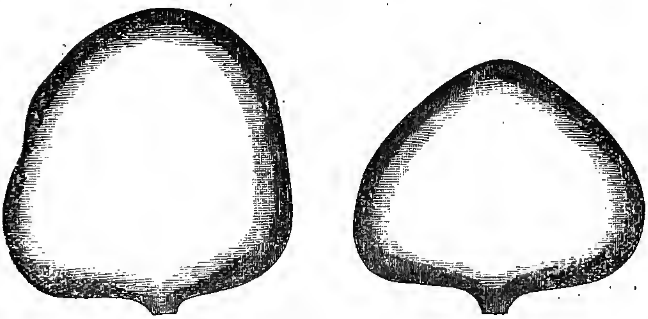

Fig. 3.—Asymmetry of bladder (Barkow).

There is a fallacy, however, in assuming that a bladder will distend when removed from the body, or even *in* the body after the viscera have been removed, in the same way as it would when in the closed abdominal cavity. For instance, in a section of a female pelvis of a girl æt. 18 by Legendre, he shows the bladder distended, not as one would expect in a young girl. Braune shows this probably arose from the bladder being distended after the viscera had been removed.

3d, In regard to the relative capacity of the male and female bladder there is a very great diversity of opinion.

For example :—

Haller says—It seemed to me greater in women, so that it contained the urine longest.

Rosenmuller—It is rounder and smaller than in the male.

J. M. Weber—Rounder, broader, and roomier than in the male.

Krause—It is roomier than in the male.

Hyrtyl—Does not strikingly contain much less urine than the male.

Encyclopædia—It is generally very capacious in women, especially those who have borne children.

Such are a few of the opinions with regard to the relative size of male and female bladders. The weight of opinion seems to be that the female bladder, especially that of multiparæ, is more capacious than that of man.

Barkow found in making the experiments, to which reference has already been made, that the female bladder contained a quantity of water equal to that contained by the male bladder.

The flattened appearance, shortened as it is in its vertical diameter, which the female bladder presents, has no doubt given rise to this difference of opinion on its capacity. Clinical observations will hardly bear out those who would limit its capacity to less than the male. A reference to retention of urine in the female would seem to show that scarcely any limit is assigned to the capacity of the female bladder. Rupture of the bladder from distension is practically unknown. The natural capacity which women have of being able to retain the urine in the viscus longer than men cannot, however, be urged as an argument in favour of the greater capacity of the female organ. This is not a matter of capacity; habit has, no doubt, something to do with it. Its deep situation in the pelvis, its broad base, its expansion laterally, must be kept in view in studying the question. It varies much with different circumstances; for example, in addition to sex and habit, age, position of the body, health, and disease, especially the latter, from a few drops to a pint, exert a marked influence. A further examination of these points would lead beyond the scope of the present inquiry.

I am now led to examine the influence exerted on the bladder

(B.) *By Pregnancy.*

1. *In the Earlier Months.*

Among the most prominent effects of early pregnancy is a diminution of the capacity of the bladder. The simple weight of the heavy uterus is of itself sufficient to cause this.

The early pregnant uterus lies in a state between version and flexion. It is easy to satisfy oneself by a bi-manual examination of the intimate relation existing between the pregnant uterus and the posterior bladder wall. The low position of the early pregnant uterus as well as its weight will check at once the upward distension of the bladder; and it would appear probable that so long as the uterus maintains this relation, say for the first three months, the bladder will not contain an amount of urine beyond that which can be accommodated by the walls distending laterally, or the fundus sinking lower in the vagina. That is, the bladder, like all other sacs containing fluid, will expand in the direction of least resistance, and this, in the case of the bladder, will be transversely. Whenever the bladder begins to distend longitudinally, the weight of the uterus will act by increasing the resistance, and hence either directly or reflexly

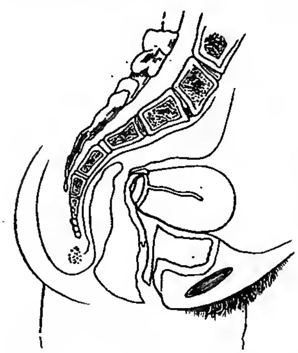

FIG. 4.—Early pregnancy (after Barnes).

require the expulsion of its contents. It is therefore only in exceptional circumstances that the bladder becomes an abdominal organ in early pregnancy. It is as a rule pelvic.

As the uterus ceases to be a pelvic organ, and with advancing pregnancy rises into the abdomen, pressure on the bladder from this cause will be modified. Clinically this is so, for frequent micturition is more common in the first months than at mid-term. Still, all through pregnancy the expanding space of the viscus is limited. But if, as is often the case, the pregnant uterus is inclined backwards without being in a state of retroversion or flexion, the bladder will be interfered with in two ways:—

1st, As urine accumulates in the bladder, and when vertical distension begins, the organ must of necessity drag on the cellular tissue lying between it and the uterus. From the position of the uterus this tissue will soon be put on the stretch, and an early check will be placed on

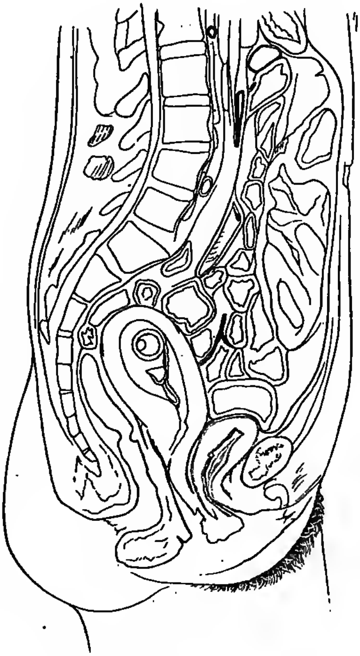

FIG. 5.—Retroverted uterus in relation to bladder (Braune).

the capacity of the bladder. The bladder will probably be emptied; if not, it will distend farther, and as it distends the posterior displacement of the uterus will be so far remedied, and the whole uterus and cervix, now closely applied to the posterior surface of the bladder, will rise *en masse* with it.

So far, distension of the bladder will have the effect of rectifying a backward inclination of the uterus. The experiments of Scanzoni and Burns show this. These were conducted on cadavera, and showed that when the utero-vesical duplicatures were severed and the bladder distended, marked retroversion was the result; but when they were left intact, distension of the bladder only served to place the anterior wall of the uterus and the posterior wall of the bladder in closer contact. Such a case has been under my observation.

A young multipara, pregnant two months, consulted me specially on account of frequent micturition. Bimanually I found the uterus slightly inclined backwards, and there being no other condition present, I concluded this was the cause acting in the way I have just described. I instructed the patient to resist the first call to micturate. This she did, and after the uterus was drawn forwards on the bladder, and had its position *quà* the cervix so far remedied, the patient was able to retain her urine for hours. The result of distension of the bladder on the uterus, when the latter organ is either normally situate or slightly inclined backwards, is to displace the *entire* organ farther back, the cervix and fundus meanwhile retaining their relative position. In the figure referred to by Braune he finds difficulty in accounting for the backward displacement of the uterus, whether it was ante- or post-mortem, or how brought about.

However it may have been brought about in this particular case, whether by the violent death of the patient or as post-mortem change, I cannot say. This much I know clinically, that such a position of the uterus in early pregnancy is by no means rare. Lately, in any case of early pregnancy, when I have been consulted, and when frequent micturition has been a symptom, I have, as occasion offered, made an examination and been struck with the frequency of this displacement.

This minor form of gravid retroversion, as well as gravid retroversion generally, as a rule, right themselves. It is otherwise with gravid retroflexion. In such a case the capacity of the bladder is interfered with as in retroversion, and frequent micturition is an early symptom; but if distension takes place the uterus is less likely to be drawn into position, and the well-known phenomena of incarceration and retention are the result. The position of the bladder during this period—early pregnancy—varies according to its distension. It seldom becomes an abdominal organ. Compressed as it is by the uterine body, or its distension interfered with by the cervix, it is usually either flattened out and of a somewhat triangular form, or else it assumes the form of an irregular ovoid.

The exact shape of the bladder during pregnancy is, of course, a matter difficult of accurate decision. The only section with which I am acquainted is Braune's, and it shows the bladder contracted and flattened against the pubes. Clinically the bladder cannot be regarded as having any definite shape, at least when moderately distended its outlines are with difficulty differentiated, and are easily changed by the pressure of the finger. It can be regarded only as a water-cushion, with easily compressible walls, and with its outlines in constant change.

The main points concerning the bladder in early pregnancy are—

1st, That it is a pelvic organ.

2d, That it distends transversely.

3d, That an antero-posterior distension is limited.

4th, That its vertical distension is interfered with for the reasons described. For these reasons its capacity is very materially curtailed.

2. *Throughout Pregnancy.*

The bladder in its moderately-distended or empty condition remains a pelvic organ. Its capacity is interfered with, but in a different way. The uterus has risen out of the pelvis. The bladder, when even considerably filled, will distend first transversely, then slightly upwards, and then the base of the bladder will bulge the vaginal wall before further upward expansion takes place. The mode of distension, therefore, of the bladder during early and late pregnancy is somewhat different. In the one case the capacity is diminished by the pressure of the uterine body, which still remains a pelvic organ; in the other, the anterior segment of the gravid uterus is the main factor in limiting the expansion of the organ.

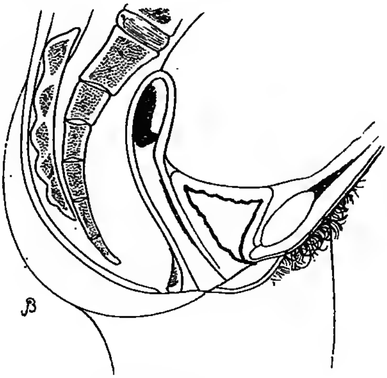

FIG. 6.—Bladder at end of pregnancy.

3. *At the End of Pregnancy.*

In primiparæ the capacity of the bladder is diminished owing to the low position of the lower uterine segment and fœtal head, and in multiparæ, just at the end of pregnancy, the result is similar (though much less marked) owing to the descent of the uterus.

In any case it is to be observed that just before labour sets in the bladder is entirely a pelvic organ, and that, except under unusual circumstances, it remains so. It expands laterally, inferiorly, and to some extent antero-posteriorly, rather than superiorly, because in that direction it meets with most resistance.

I now come to look at the bladder

4. *During Parturition*

The main point to be observed, so far as my present subject is concerned, is the fact that the urethra is elon-

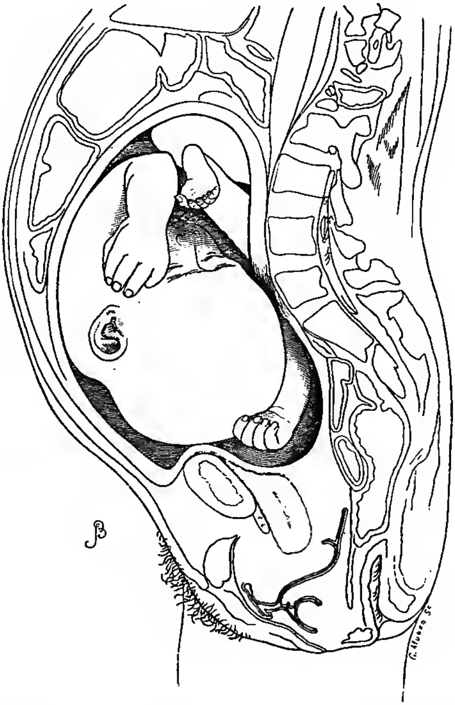

FIG. 7.—Position of bladder at end of pregnancy and before onset of labour (Braune).

gated and the bladder elevated. This is well shown in Braune's sections, and has been specially studied by Hart, to whose work in this department I am particularly indebted. It is a fact which readily admits of clinical demonstration ; the direction of the urethra, the length of catheter required, the small quantity of urine often drawn off, as well as the results of a vaginal examination, sufficiently prove that, under normal circumstances, during the first and second stages of labour, the bladder has ceased to be pelvic and become an abdominal organ.

This is the case not only under circumstances of distension, but, as Braune's plates abundantly show, in the empty condition as well. The cause of this alteration in the position of the bladder is to be explained by a study of the pelvic floor during parturition, and specially by a consideration of the relation of the cervix and bladder. The intimate relations between the cervix and the posterior bladder wall sufficiently demonstrate the cause of this displacement. During the first and second stage of labour the cervix is stretched, thinned, and correspondingly drawn up. As it undergoes this change the bladder alters its position and rises with it, a movement of which it is capable owing to its loose pubic attachments. From being pelvic it becomes abdominal. This is the case, not in part but in whole, whether distended or empty. This altered position of the bladder during parturition is full of interest as bearing on various obstetric operations and manipulations. A reference to these points would lead me away from my present object. I am contented with drawing attention to the importance of keeping this position in view in relation to bladder pressure.

Clinically the distended bladder is readily recognised

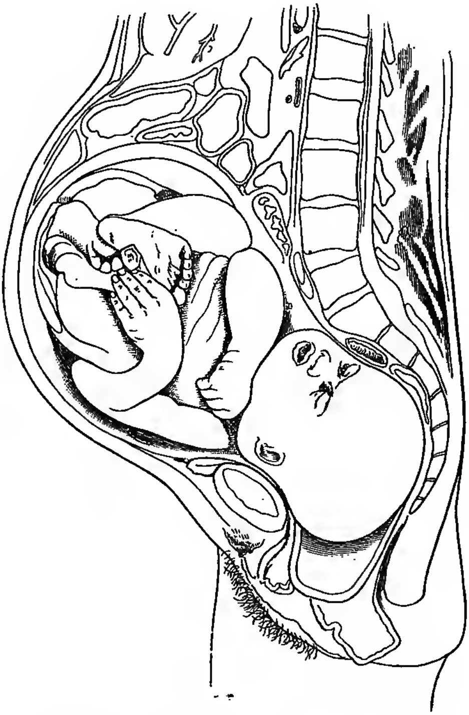

FIG. 8.—Relation of bladder and urethra during labour (Braune).

by inspection and palpation forming a distinct tumour suprapubically broader above than below, separated from the surrounding uterine tumour by a transverse or oblique furrow. Its tenseness and fluctuation will further decide its nature.

I wish to take this opportunity of indicating a further diagnostic point. The condition has not been drawn attention to. It may be, and no doubt is, familiar to practical accoucheurs, but, if it is recorded, any notice of it has escaped my observation. The condition is pathognomonic, but owing to the firmer relation of the tissue it is most marked in primiparæ. I mean an alteration in the vaginal walls, by which, owing to the dragging up of the bladder, a circular contraction is formed—most marked in front but extending all round the vagina. The lumen of the contraction varies with the amount of urine in the bladder.

Let me illustrate what I mean by a few clinical examples :—

Case 1.—I. S., a primipara, had been in labour since morning; saw her at 8 p.m., found os dilated as large as a half-crown. In front of the cervix the vagina was drawn into a ring with firm sharp outline. Through this ring the cervix could be felt.

Inquiry—Patient has not passed water since morning.

℥xi urine drawn off with a catheter.

Result—Vaginal ring disappeared.

Case 2.—R. B., primipara, seen at morning visit 9 a.m.; os size of a penny-piece, well marked ring in front of the cervix.

Inquiry—No urine passed since late on previous evening.

℥x urine drawn off with a catheter.

Result—Vaginal ring gone.

Case 3.—A patient was brought into the Maternity Hospital in labour, having come a long distance by train. The os was dilated as big as a crown-piece. In front of it the vaginal ring was well marked; its lumen being less than that of the cervix. The distended bladder formed a well-marked suprapubic tumour.

Inquiry—No urine for many hours.

℥xx drawn off with a catheter.

Result—Ring disappeared.

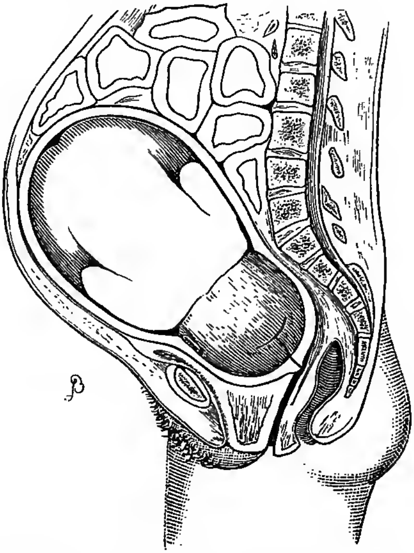

FIG. 9.—Position of bladder in first stage—undilated os, cervix thinned out over head.

It can serve no good purpose to multiply examples, and as I have not kept a record of all the cases in which this condition was observed, I am not in a position to give a table. There are one or two points which I think call for notice.

1*st*, I have observed that the condition is most marked in primiparæ, although it does occur in multiparæ.

2d, It occurs in the first stage.

3d, It is rare in the non-gravid. This can be proved by experiment. I have again and again examined the vagina in non-gravid women with a full bladder, and have seldom found such a ring.

In primiparæ and in the first stage this ring is pathognomonic of distension. It is worthy of notice that a marked ring will be caused even if the bladder is not distended to any very great amount, that is to say—as I have shown in the cases recorded—℥x will do it. I have not noticed it with less. Of course regard must be had to the condition of distension in labour and in the non-gravid; for though ℥xx may be allowed as an average moderately-distended bladder, less than half that quantity must be regarded as moderately-distended bladder in labour. Indeed distension, even moderate distension, is a very rare thing in parturition. Although constantly referred to, it must strike the practical accoucheur as a fact, that except as routine and then with questionable benefit the catheter is comparatively seldom required in labour. The condition is deserving of a little closer study.

1st, The bladder has been seen to be abdominal.

2d, The direction of distension must be transverse and longitudinal.

The altering shape of the uterus and its contractions prevent antero-posterior distension.

3d, The swelling formed suprapubically by the moderately or markedly-distended bladder is not, as might be at the first glance expected, central.

I have observed this at the hospital. Out of 15 cases of which I have kept notes the following is the result:—

15 cases of parturition in which during inspection the characteristic swelling of the distended bladder was observed, and in which, after the use of the catheter, it disappeared.

In 8 swelling to *Right* of mesial line.
„ 4 „ „ *Left* „
„ 3 „ was *Central.*

Of the 8, in every case the presentation was cranial, and the position L.O.A.
Of the 4, in 3 body was to *Right.*
„ 1 presentation indefinite.
Of the 3, 2 were pelvic, 1 cranial L.O.A.

In looking for an explanation two considerations must be kept in view.

1st, That central distension is to a certain extent prevented by the position of the head and body, and then too whether the head is engaged or not.

2d, The natural asymmetry of the bladder. To this I have already alluded in detail.

In addition to the fact that the bladder in parturition is abdominal, it is important to keep the two points I have just mentioned in view, as affording additional explanation of the small quantity of urine required to make a suprapubic vesical tumour during labour.

The first of these is very fully borne out by the short table I have given, in which, out of the 15 cases 11 were apparently influenced by the head and body, or both. The remaining 4 were too indefinite to draw conclusions from, but it is striking that in both of the pelvic cases the bladder was central.

Following the arrangement laid down at the commencement of this inquiry, I have now to describe the method adopted of arriving at an estimate of the amount of pressure exerted on the bladder during parturition, and the results of that inquiry.

1. *The Method adopted in making the Experiments.*

A bent U tube one-eighth of an inch in calibre was connected by the end B with a horizontal tube C, in which was a T branch E closed with a pinch-cock D. (See Diagram.)

To the farther end of C was attached a piece of stiff india-rubber tubing of the same calibre. This was about 2 feet long, and terminated in a soft rubber catheter No. 8.

At the point of junction of the tube C and the catheter another T branch I was connected. This was also closed with a pinch-cock H.

A scale divided in both directions was fixed between the limbs of the tube, and was capable of accurate adjustment to the mercurial level.

The instrument was arranged for observation in the following way :—

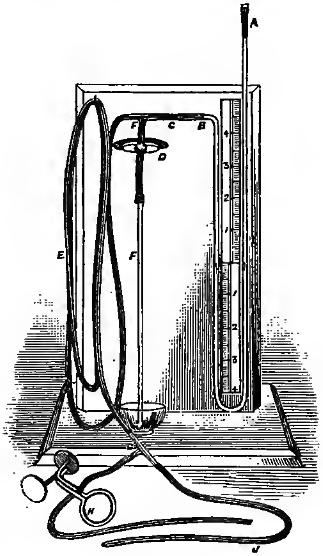

Fig. 10.

The whole apparatus was filled with water so as to exclude air: mercury was then poured in at A so as to displace the water, and until about 3 inches stood in each limb. The fluid in the limb A was then adjusted above the mercury, until a column of the same height remained as existed between the level of the mercury in B and the horizontal tube C.

This ensured an equal weight of fluid in both limbs.

The scale was then carefully adjusted till the zero corresponded to the mercurial level.

The catheter was then introduced into the bladder, and the manometer adjusted on the support to the same height as the bed.

The pinch-cocks H and D were opened, and a little urine permitted to flow so as to secure complete exclusion of air, and equalise the pressure on both sides of the mercury.

Both cocks were then firmly secured, and alterations in the mercurial level during each pain observed.

When it was desired to ascertain the amount of urine in the bladder, the tap H was opened and the urine was allowed to flow out.

In those cases where the bladder was found to be empty, or nearly so, ℥ij of water were injected. This was done by connecting a Higginson syringe to the tube.

When a suitable case presented itself at the hospital the apparatus thus described was employed, and as much care as possible was observed in recording the variations in the mercurial column at different periods of labour. That the observations are relatively few, compared to the amount of cases in the hospital, is sufficiently accounted for by the following facts:—first, that many cases were admitted too far advanced in labour to be of any practical use; secondly, that many patients resented the interference; and thirdly, that even in those cases which were available it was often impossible for me to be present.

The results of the observations have been carefully tabulated, and will be found in a series of tables at the end.

Table 1 shows that the observations extended over periods varying from 5 to 40 minutes, and included from 2 to 9 observations on each patient.

The table to which I now draw attention, No. 1, indicates the condition generally, showing the state of

1. The os.

2. The membranes.
3. Presentation and position
4. Situation of the head.
5. Limits of observation.
6. Duration of observations.
7. Maximum rise.
8. Minimum rise.
9. Amount of urine.

This table gives a *prècis* of the whole scope of the observations, and from this table all the others have been constructed.

These observations were made exclusively in cases of head presentation.

The cranial position being—

L.O.A. .	19
R.O.P. . . .	6

The situation of the head was—

Brim.	Cavity.	Outlet.
4	26	5

The condition of the membranes—

Ruptured, 16. Unruptured, 17.

The condition of the os—

Dilated 19. Undilated, 13.

In making these observations very considerable care had to be observed in eliminating any sources of fallacy, more especially in the observations made during the early period of parturition. One such fallacy, which I now show, has crept into the tables. I refer to the possibility of taking a reading during the first stage while the patient is making active exertion, such as coughing, bearing down, vomiting, and the like. Such exertion on the part of the patient altogether vitiates the readings, because such voluntary efforts at once remove the reading from that of a first to that of a second stage. As the sequel will show, I have endeavoured to make ample allowance for this.

Reading during Interval.—Among the first points which require to be settled is the reading of the mercury during the interval of a pain when uninfluenced by any of the factors of labour. This is uniformly .2 of an inch. We get this reading under all circumstances during the interval of a pain. The condition of the bladder as to repletion makes no difference. The mercury remained the same in a woman with three ounces in her bladder as in the case of a woman suffering from puerperal melancholia from whom nearly two pints were drawn off.

A very slight alteration in the position of the manometer will raise the mercury a point or two. When the patient is still and the bladder and manometer on the same level, the rise of the mercury is really inappreciable, and cannot therefore be included in our calculations as in any way influencing the result.

A series of experiments were tried with non-pregnant women, and the results were, that perfect stillness and accurate adjustment of the patient and manometer leave the mercurial column unaffected. We must attribute this reading during the interval to this fact, that the mercury was on a slightly lower level than the patient.

Such a condition of matters can, indeed, hardly be avoided, from the fact of the patient lying in a non-rigid bed, or from the varying thickness of the patient's buttocks.

It therefore follows that during the interval intra-vesical pressure amounts to *nil.*

I have thought it necessary to draw attention to the fact, because on comparing the graphic tracings obtained by Poullet by his Toko-graph with my own, to which I refer further on, it will be found that Poullet obtained a continuous elevation of the mercury during the whole period of the experiment ; both during a pain and during the intervals. This rise varied from 15 to 20 m.m., and indicates a continuous uterine tension. This is quite different from the .2 in. to which I refer in my own experiments, which simply indicates a difference between the level of the manometer and the position of the patient.

Such being the condition of the mercury during the interval of a pain, a glance at Table 2 will show at once the influence which parturient efforts have on the bladder. The table shows a range of readings varying from 3.2 to .1, and the scale is wonderfully gradual. From a closer examination it will be seen that the *highest* reading occurs in a primipara æt. 27, with vertex presentation, L.O.A.

position, dilated os, ruptured membranes, and head in the cavity, well on therefore in the second stage of labour; and the *lowest* reading occurs in a primipara, æt. 27, vertex presentation, L.O.A. position, os the size of a shilling, ruptured membranes, and head at the brim, early, therefore in the first stage of labour.

Such results are precisely what one would *à priori* expect. Between these two extremes the readings vary with varying conditions of labour.

In the meantime the fact is established that pressure, and that to a very considerable extent, is brought to act upon the bladder during labour. Having seen the limits of pressure, viz. the highest and lowest readings, it is convenient here to inquire what the equivalents to these readings are in actual pressure.

Take, for example, the maximum in which the mercurial column rose 3.2 inches. As all these readings refer only to the rise of one limb of the manometer, they require to be doubled in order to represent the actual height of the mercury supported by the bladder pressure for the time being. Accordingly, 6.4 inches of mercury will represent the corresponding intra-vesical pressure in this observation. Now, as 30 inches of mercury represent approximately a pressure of 15 lbs. on the square inch, it becomes a simple question of proportion to ascertain the amount of pressure corresponding to 6.4 inches. This I find to be 3.2 lbs. per square inch of bladder area. In Tables 6, 7, 8 the manometric readings are converted from inches into lbs. of pressure, and these tables show the actual pressure per square inch of bladder in each of the separate observations made. The lowest reading which was obtained was .1, which represents .2 inches of a mercurial column, and this again is equivalent to $\frac{1}{10}$ of a lb. of pressure on the square inch.

Such being the highest and lowest readings, it would be possible to determine the entire intra-vesical pressure, provided always it were practicable to obtain—

1st, The exact quantity of fluid contained in the viscus.

2d, Sufficient data as regards the displacement of the walls to calculate the entire intra-vesical area.

Such a calculation would serve no good purpose in indicating any solution as to the distribution of uterine force, because, as will be shown, the chief factor in the causation of the pressure is a variable quantity, resulting as it does from the action of an unknown segment of the uterus on an unknown area of the abdominal walls and pubes. Were the bladder a rigid cylinder, and the uterine force acting directly upon the fluid contained within it, it would be easy to estimate the precise sum of the force expended on it, but its walls being more or less elastic it would be necessary to determine both the degree and quality of that elasticity as a basis of any calculation in this direction. Means for such calculation are not at our disposal, and thus we must be content with having ascertained the amount of parturient pressure dissipated on the bladder at various periods per square inch.

What, then, is the source of this pressure? Is it fœtal, *i.e.* is it due to the advancing head of the child? That it is not so is evident from the fact that it is greatest during the second stage of labour, when the head has, as I have already shown, passed below the level of the bladder. The bladder has been drawn out of the pelvis into the abdomen, and therefore away from direct pressure from the fœtal head. The pressure cannot therefore be said to be the result of the fœtal parts coming in contact with the viscus under observation. This fact is worthy of special notice, because unless the position of the bladder during labour is kept clearly in view, one would very naturally regard the pressure exerted on the bladder as a direct result of the advancing fœtal head pressing on it. Such inference is clearly erroneous. Little, if any, pressure is thrown on the bladder from this source. In order to remove any possible source of doubt on this question, I made a few manometric observations during forceps delivery, and found that when marked traction was made on the head with the forceps, there was absolutely no rise on the mercurial column in the absence of a pain, and even during pains traction did not increase the pressure indicated. These facts are sufficiently convincing that the pressure of the advancing fœtal head on the bladder is not the cause of the alterations of the mercury.

There remain, therefore, two sources from which this pressure may arise—

1*st*, The contraction of the uterus.

2*d*, The contraction of the abdominal walls.

1. *Uterine Contractions.*

I have just shown that these do not act through the fœtal head by communicating the pressure directly from the head to the bladder wall. This source of pressure must therefore to a great extent be dismissed. Uterine contractions have another and separate influence on the bladder. This is exerted in two ways—1*st*, By altering the shape of the uterus. The effect of uterine contraction in altering the shape of the uterus is well recognised.

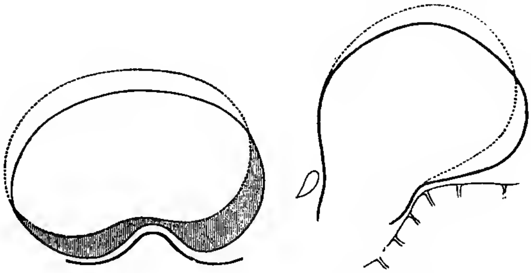

FIG. 11.—Alteration in form of uterus during labour (Lahs).

Towards the end of pregnancy the uterus is ovoid in form, during a pain it becomes more or less globular.

The longitudinal and transverse diameters diminish while the antero-posterior is enlarged, in other words, while it shortens from above downwards it lengthens antero-posteriorly, *i.e.* in the direction of the bladder.

Further, it must be noticed that with a distended bladder the effect of this "form-restitution power" will be more marked, because, as a matter of fact, owing to the tightening of the broad and round ligaments, the fundus uteri is thrown somewhat forwards, so that the circumference at the umbilicus becomes proportionately greater than that between the umbilicus and symphysis.

The case stands thus:—

During a contraction in early labour, before the abdominal walls either reflexly or voluntarily have begun to act, the "form-restitution power" of the uterus exerts a pressure on the bladder most when the membranes are unruptured and the abdominal walls firm. This influence in its simplest form will be observed early in labour. Hence, with uterine contractions, there must of necessity be a certain amount of pressure from the altering shape of the uterus itself. This, of course, will be greater as the abdominal walls are tense, and this form of pressure will be most marked in primiparæ, in whom this condition is more pronounced. Further, the presence of the liquor amnii will modify this form of pressure considerably, for its presence will increase the size of the uterus, especially in its lower segment, and so, with unruptured membranes, the force exerted by this form of pressure will be greater than after the liquor amnii has escaped. Table IV. specially shows this, and to this table I draw attention.

But 2*d*, Another influence arising directly from uterine contraction must not be overlooked, viz. the pressure induced by the stretching of the cervix. As the cervix dilates it is drawn up, and with it the posterior bladder wall. Now, this dilation of the cervix must not be regarded simply, or even perhaps mainly, as a result of the pressure of the fœtal head or the amniotic wedge, but specially as a result of the contraction of the longitudinal fibres of the uterine body dragging up the cervix, and with it the bladder, to whose posterior wall it is firmly attached by the paravesical cellular tissue. Further, the comparative thickness of the uterine walls, anterior and posterior, during labour, shows the anterior to be thicker, owing, no doubt, to its greater contraction, as has been demonstrated and explained by Dr. Hart. Thus we have a very important factor in bladder pressure, causing direct pressure on the viscus, and reflexly giving rise to contraction of the bladder, and, under certain circumstances, to spontaneous expulsion of its contents. This question of spontaneous expulsion of urine during labour is an interesting one. I have noted the following facts with regard to it:—

1st, I have never seen it occur except during a pain, when therefore both urethra and bladder are on the stretch. 2d, I have not observed it occur during a pain except under the following circumstances:—

(*a.*) During the introduction of forceps when a pain occurs. In this case two factors probably are at work—(1) the removal of pressure from the urethra by the hand; and (2) the dynamic action of the hand in the vagina.

(*b.*) During internal rotation. When this occurs suddenly, especially when it takes place low down in the pelvis.

(*c.*) In women with a lax vaginal wall, and in whom the pubic segment of the pelvic floor rises, but not sufficiently to drag the bladder out of the pelvis.

(*d.*) In old multiparæ with a gaping urethra.

(*e.*) In women with a large pelvis and a small fœtal head.

Other causes may, no doubt, be at work in producing this. I have simply indicated those which have come under my own personal observation.

A further discussion of this question would lead me away from the object of my present study. We have seen the *modus operandi* of pressure exerted by the uterine contraction on the bladder. We shall see further on what this pressure amounts to. In the meantime, regard must be had to another source of bladder pressure during labour, viz. (2) *From contraction of the abdominal walls.* As the table shows, the pressure during the second stage gives the highest readings, and as during the second stage the membranes are ruptured and the head in the cavity, the abdominal contraction would seem to be the source of the greatest pressure. The influence of the abdominal muscle will be brought to bear directly on the bladder, pushing it against the resistant body of the fœtus; for it must be admitted that the voluntary efforts, although not confined to the second stage, usually are so; and it is hardly possible to conceive that reflex contraction of these muscles will take place before labour is well advanced. It seems to be natural now to try to estimate the amount of pressure from these sources. A study of Tables III. and IV. shows—

1. The lowest reading when the os is but slightly dilated, say to the size of a shilling.
2. An increasing amount of pressure with an increasing size of cervix.

Now, it appears to me that this enables us fairly to estimate the amount of pressure which may reasonably be credited to the first two named factors. When the os remains about the size of a shilling, the contraction of the uterus will alter its shape, and so bring about pressure in the way I have previously described; while, as the cervix gradually enlarges, the second element—viz. the dragging up of the bladder by the cervix—will be brought into play. A reference to Table III. is sufficient to demonstrate this. This table shows the relation between bladder pressure and cervical dilation, and shows that the pressure on the bladder is in direct ratio to the increasing size of the cervix. That there are exceptions to this is only what might be naturally expected. With readings of single points under such circumstances, absolute uniformity can hardly be attained, but in the main the point indicated is proved. As I mentioned in an earlier part of this study, p. 34, unusual rises in the readings are to be found here and there, occurring through some accidental voluntary effort on the part of the patient; they must, therefore, be eliminated.

It will be observed that three such high readings are recorded under readings with undilated cervix. In each of these cases there was some unusual and uncalled-for effort on the part of the patient. These three high readings, on glancing at the chart, tell at once where voluntary effort comes in. From the table I show, it may be assumed that the pressure during the first stage of labour, *i.e.* with an undilated cervix, varies from .1 to .6 inches. These low readings occur equally in primiparæ and multiparæ, and were taken, with the exceptions noted, when the patient was lying quite still on the back.

The increase of pressure, therefore, can only be accounted for by the altering shape of the uterus pressing the bladder against the abdominal wall, or, as is the case in very early labour, against the symphysis pubis, and as the labour advances, by the bladder being drawn and pressed on by the cervix.

The following are examples of the readings I refer to :—

Multiparæ.

Cervix.	Reading.
Shilling	4
Shilling	4
Florin	5

Primiparæ.

Shilling	1
Crown	2
Crown	3
Florin	3
Wine-glass	6

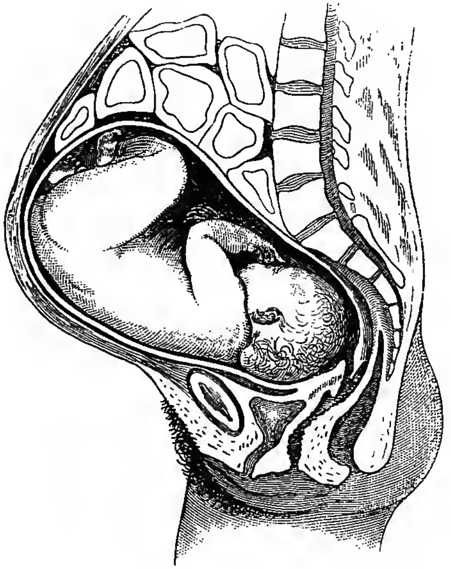

FIG. 12.—Position of head in a primipara.

It is striking that these readings correspond so entirely in primiparæ and multiparæ. It would I think be, *à priori*, expected that the readings even at an early stage would be greater in primiparæ than multiparæ. This is not the case. They are apparently the same. Presumably the walls of the abdomen being more tense and unyielding in primiparæ, the uterus would have a firmer body to press against than against the comparatively lax abdominal walls of the multiparæ. The tables, however, do not support this. It becomes necessary to look for an explanation of this. Now the relative positions in primiparæ and multiparæ throw some light on the question.

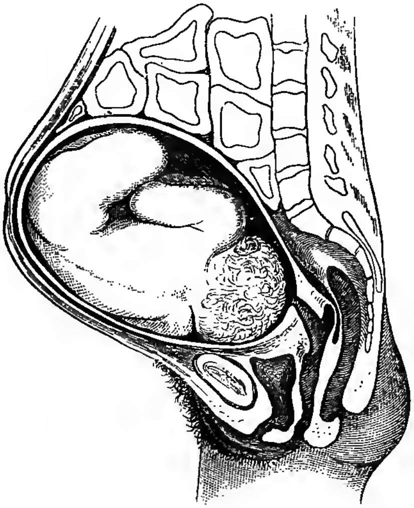

FIG. 13.—Position of head in a multipara.

For while in the multiparous woman the head in early labour remains comparatively high, in the primiparous woman, long before labour has set in, the head, with the lower uterine segment, has sunk deep into the pelvis.

Hence what the primipara gains by tense walls, she loses by the fact that the head has sunk beneath the reach of the bladder, whereas in the multipara the whole lower uterine segment and the contained fœtal head remaining high, at or near brim, the whole influence of the form - restitution power and cervical dilation come to bear on the bladder. It must be further kept in view that in conditions of moderate distension, the pressure will not be against the yielding irregular abdominal walls, but invariably against the symphysis.

This being the case, it is not matter for surprise that the readings in most multiparæ and primiparæ should be the same.

I have not yet got experiments to show whether the readings in multiparæ and primiparæ are the same with a *distended* bladder, where of course the pressure will be between the uterine wall on the one hand and the abdominal parietes on the other. As will be seen from my tables, in all my experiments the bladder was but moderately distended.

All the tables have a urine column, in which this is indicated.

It becomes desirable to define the term *distension* a little more minutely.

There are four conditions under which the bladder may be met with.

1st, A condition of *total emptiness*, in which the bladder walls are in close apposition.

This apposition during parturition will be one of anterior and posterior wall, never of upper and lower, as is sometimes the case in the unimpregnated condition.

2d, A condition of *moderate distension*, when the bladder walls will have begun to separate and take a definite outline. A very small quantity of urine is sufficient to do this.

Neither of these conditions is recognisable by any special clinical feature. Such can only be diagnosed negatively.

3d, A condition of *distension*.

This differs somewhat in parturition and in the non-pregnant condition.

For while ℥xx may be regarded as a moderately-distended bladder in the non-pregnant condition, half that quantity will be sufficient to produce moderate distension in the parturient woman. Further, while ℥xx gives no clinical feature in the non-gravid woman, little more than ℥x will give the characteristic tumour suprapubically in parturition. The cause of this has already been drawn attention to by Hart, and I have sufficiently referred to it in speaking of the anatomy of the bladder.

4th, A condition of *over-distension*.

Between moderate distension and over-distension no absolute clinical line can be drawn, but a simple manometric experiment will illustrate the point. Given a bladder containing a quantity of urine not sufficient to stretch the walls to their fullest extent, and given a certain external pressure on the viscus, no effect need be produced on the mercurial column provided that the walls have still sufficient room to accommodate the altered shape of the fluid mass. But supposing with the same amount of pressure the bladder walls are tense, or have no room to distend, then such pressure will at once be indicated on the column.

Such a condition is one of distension. It comes to this, that so long as the resistance of the bladder walls is less than the resistance of the column of mercury, the manometric readings will be unaffected.

The pressure of labour on the bladder flattens it antero-posteriorly, and so long as the bladder can extend longitudinally or transversely with less pressure than is necessary to affect the mercurial column, the readings with large and small amounts will be the same.

Suppose, for example, that the point of over-distension is, say ℥xxx, and that the viscus contains that amount, the result will be different, for in that case a very small pressure will cause a high reading, because, owing to the rigidity of the walls, the column of mercury will be more easily displaced than the vesical parietes.

Table V. shows this graphically. The abscissa shows the amount of urine, while the ordinate shows the corresponding pressure, and it will be found that the highest readings obtained were with quantities of urine varying from ℥i to ℥ii, while with ℥xiv and ℥x respectively the readings were comparatively low.

The former gave an average of 3 inches, while the latter gave an average of 1 inch. So that really, and for the reason I have shown, it makes no difference whether the bladder contain much or little urine, provided always the point of over-distension be not reached before pressure is applied.

Summary.

The main points of this paper may be summed up as follows :—

1*st,* That pressure is brought to bear on the bladder during labour.

2*d,* That during the interval of pain bladder pressure amounts practically to *nil.*

3*d,* That in ordinary labour the maximum pressure is about 3.2 lbs. on the square inch.

4*th,* That this pressure is obtained during the second stage of labour, but that equally high readings may be got during the first stage, when, by accident, any voluntary effort is interposed.

5*th,* That in ordinary labours the minimum pressure amounts to .1 lb. on the square inch, and that this is found during the first stage of labour.

6*th*, That the average reading during the *first* stage of labour amounts to—

a. Inclusive of accidental high readings, .92 lb. on square inch.

b. Exclusive of accidental high readings, .42 lb. on square inch.

The latter may therefore be regarded as the correct estimate.

7*th*, That the average reading during the *second* stage of labour amounts to 1.88 lb. on square inch.

8*th*, That when regard is had to the position of the bladder during parturition the sources of the pressure are three—

a. Change of shape in the uterine ovoid.

b. Stretching of the cervix.

c. Pressure by the abdominal and other respiratory muscles, *e.g.* Diaphragm, levator ani, etc.

9*th*, That of these three sources that derived from the abdominal walls is the greatest.

10*th*, That pressure seems in no way to be influenced by the patient being primiparous or multiparous.

11*th*, That the quantity of urine in the bladder does not influence pressure, provided always the point of overdistension is not reached.

The experiments from which the foregoing conclusions are drawn are added in a tabular form, and are arranged as follows :—

Table I. is a general statement of the experimental results, showing—Age, number of labour, commencement of labour, condition of os and membranes, presentation and position, situation of head, length of time during which the observations were conducted, number of observations in each case, minimum rise, maximum rise, quantity of urine.

Table II. shows the experiments arranged in a descending series, the pressure being indicated in inches of mercury.

Table III. shows the experiments arranged according to the number and stages of labour.

Table IV. shows experiments arranged according to the number of labours and the condition of os and membranes.

Table V. shows experiments arranged according to quantity of urine in the bladder.

Table VI. gives inches of mercury converted into pounds, showing pressure per square inch of bladder area in undilated primiparæ.

Table VII. shows the same in dilated primiparæ.

Table VIII. shows the same in dilated and undilated multiparæ.

Note A.—It is well to point out that this maximum pressure, viz. 3.2 lbs., represents the pressure brought to bear on the bladder by the powers of parturition through some part of the uterine contents, not, however, on any of the points embraced by the girdle of contact. If the girdle of contact means, as Lahs says it does, the ring by which is embraced the largest diameter of the fœtal head, I have at considerable length endeavoured to prove that in ordinary labour, in the second stage, the bladder never forms any part of the girdle.

Note B.—It would seem at first sight an easy matter, given the pressure on one part of the pelvis, to calculate the pressure on the rest. Such, if it were possible, would be a ready method of determining the resistance of passages and the force lost in them. There are two difficulties—

1st, It is impossible to ascertain the amount of surface included in the girdle of contact.

2d, The bladder does not form part of this girdle.

Note C.—It is a somewhat remarkable fact that the figure 3.2 lbs. per square inch of bladder corresponds so nearly to Haughton's 3.4 lbs. per square inch as a result of the extreme force of the uterine contractions. It is necessary to point out that this is but a coincidence, there being no relation either as to cause or effect between the two pressures. The absence of relation between the two will become apparent when we consider—

1st, That Haughton's figures represent the sum of uterine pressure brought to bear on the fœtal head.

2d, The figure 3.2 as a result of my own experiments represents the maximum force brought to bear by the action of the voluntary muscles on the bladder.

THE BLADDER DURING THE EARLY PUERPERIUM.

In the previous section I have discussed some clinical features of the bladder during pregnancy, and specially the pressure exerted on it by parturition. I now desire to draw attention to some conditions of the bladder during the normal puerperium. During the second stage of labour the bladder is either voluntarily or involuntarily relieved of its contents, so that at the conclusion of the third stage the organ is usually empty. Immediately succeeding the third stage, and during the early puerperium, the bladder exerts an important influence on the uterus. This influence is mainly observed as affecting the position of the uterus. It is convenient here to look at the relative positions of bladder and uterus. The bladder has sunk down into the pelvis from the abdomen, and after labour is to be found, usually empty, lying below the brim of the true pelvis, but on a higher level than during pregnancy. For while the bladder, when empty or slightly distended, is spread out below the anterior uterine segment so that, on introducing a catheter, its distal end and the meatus are on the same level, and in some cases the fundus is lower than the meatus, after labour this relation no longer exists; for, the inlet of the pelvis becoming free, and pressure being removed from the bladder, the organ is allowed to expand upwards, so that a catheter goes no longer directly back, but its point is directed upwards, and is consequently elevated above the level of the meatus.

The uterus, as to position immediately after labour, varies. It is pressed forwards by the action of the abdominal muscles acting on its posterior surface. But it may be said roughly that its fundus, some hours after delivery, is to be found at or quite close to the level of the umbilicus. Immediately after labour, I have said, it varies, being sometimes so deep in the pelvis as to be scarcely felt, and at all times its level immediately after delivery is lower than after the lapse of a few hours. The organ is inclined forwards so that the anterior surface of its fundus is in close relation to the anterior abdominal wall, through which it can always be readily palpated. The organ is too large to fall below the promontory, and in the ordinary

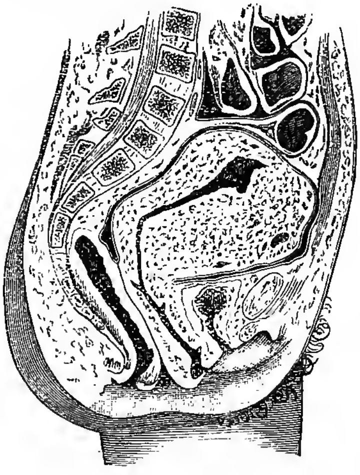
FIG. 14.—Post Partum uterus and bladder.

position the pressure of the intestine is directed on the posterior wall. It is usually found occupying a central position, although deviations from the mesial line are very frequent. I do not now refer to distinct displacements, but simple deflections of the uterus to one or other side. Out of 60 cases observed at the Maternity Hospital, 14 deviated, 4 left, 10 right; 46 were median. Börner noted 64 cases; 53 median, 11 deviations.

Such is the relative position of uterus and bladder when the latter viscus is empty. While the bladder is filling and after it is distended various changes take place in its relation to the uterus. Unlike either early pregnancy, where its expansion is interfered with by the anteverted uterus, or late pregnancy, where it is limited by the anterior uterine segment, or parturition, where it is compressed between the abdominal wall and uterine body, the post-partum bladder meets with no obstacle to its distension upwards. Its recognition suprapubically is simple enough. Per vaginam, when the bladder is distended, through the anterior vaginal wall is felt a firm elastic swelling which completely fills the anterior vaginal arch and presses it down. The cervix is high up and well back, and it is impossible to feel any part of the anterior uterine wall in front of the cervix, unless, indeed, very considerable pressure is made on the uterus from above.

The most obvious effect which distension of the bladder exerts on the uterus is familiar to every practical accoucheur. If the hand is passed over the abdomen twelve or fifteen hours after labour, and the fundus uteri is felt high and far back from the abdominal wall and less distinctly palpated, the explanation is to be looked for in a distended bladder.

We have thus displacement upwards. The term displacement does not, however, convey accurately what occurs. No doubt there is a certain amount of ascent of the uterus. This is small. The heightening of the fundus uteri is brought about through the distending bladder straightening the uterus and making it upright. As the bladder increases in size the uterus is pushed further back from the abdominal walls. Some of the intestines in this way slip down between the uterus and abdominal parietes, and then palpation is rendered more difficult. It is not so much a mere dragging up of the uterus as an increase in its real height by the straightening of the organ. In Autefage and Depaul's experiments with the hysterometer—an instrument constructed like a pair of compasses, one branch being applied to the cervix through the vagina, and the other externally at the fundus uteri—reference is made to this point. By means of this instrument, devised by Depaul and carried into practice by Autefage, it was attempted to estimate the rate of involution of the uterus. Autefage mentions that the actual length of the uterus was increased while the bladder was distended, and that the organ returned to its normal size when the bladder was emptied.

There seems to me to be a fallacy here, for with a full bladder the distance between the two buttons of the hysterometer will be increased owing to the bulging of the vesical tumour rendering the whole organ more erect, and, again, owing to the displacement of the cervix further back in the vagina. In order to ascertain the fact of increase in the cavity of the uterus the measurements would require to be taken with the uterine sound.

I have just said that the normal puerperal uterus is central. This, however, is a point upon which there is apparently some difference of opinion. For while some, as Schrœder, and with him the majority of observers, hold that the usual position of the uterus is right lateral deviation, others, such as Börner, maintain that in the majority of cases the uterus is central. It is important, in studying the effects of bladder distension, to look at this question shortly.

Considering the great preponderance of right lateral deviation of the pregnant uterus, such an inclination during the puerperium is just to be expected. For instance, in the table given by Joulin from Dubois and Pajot, among 100 women, in 20 there was no deviation, in 4 there was a deviation to left, in 76 to the right. This right lateral deviation is not only to be expected, but, as has been shown by the authors above mentioned and by many other observers, is really the case. Yet the more accurate observations of Börner go to throw some doubt on this point, for they show that when certain conditions are imposed the central lie of the uterus is found to be the most common—out of 60 cases, 52 were mesial, 4 to the right, 1 to the left; or, in the 60 cases taken during my own term, where the same conditions were observed, in 46 there was no deviation, in 10 deviation to the right, 4 deviation to the left. Now these conditions are—1. An empty bladder; 2. An empty rectum; 3. The supine position of patient.

When these conditions are observed, it will be found that the mesial position is the most frequent, and, being the most frequent, therefore the normal one. My own observations bear this out, and I have found that when lateral deviation was masked with either a loaded rectum or a somewhat distended bladder, the mesial position was resumed when these organs were emptied. Further,—and this is a point which is not sufficiently insisted on,—the position of the patient has a great deal to do with these deviations. A very slight deviation of the body to one or other side is sufficient to give the organ a set in that direction, and Pfannkuch has shown that even in cases where the uterus had the right lateral deviation well marked during pregnancy, a few hours' lying on the left side is sufficient to change the whole relation of parts. This is a fact of which there is abundant clinical evidence. I have frequently, in noting the position of the uterus post-partum, fallen into the error of recording the lie as lateral—this being due to the patient lying on one or other side immediately before, for I have observed that the organ does not resume its central position until the patient has assumed the dorsal decubitus for some time. Now, a very inconsiderable lateral inclination of the pelvis is sufficient to cause this. It is therefore absolutely essential, in settling the question of the most common lie of the uterus, to insure that the pelvis be horizontally placed on the bed. This lateral displacement of the uterus by the accidents of position is of importance when we come to look at the influence of the distended bladder on the post-partum uterus, which is almost uniformly to cause a *lateral deviation* of the organ. A central uterus becomes laterally displaced, and one which is originally laterally displaced becomes more so. This condition is almost uniform. It is very rare to find the uterus central with a full bladder. The displacement is to a certain point in proportion to the repletion of the bladder; but a comparatively small quantity of urine is sufficient to throw the uterus from the mesial line. Now, this deviation may either be right or left.

Kehrer made an experiment on a cadaver by artificially filling the bladder, and found a lateral inclination of the puerperal uterus with the fundus to the right.

Clinically observed, the right deviation is the more frequent. This, however, although it has the support of the majority of observers, and although it is the deviation which is most easily explained, does not seem to be so frequent as alleged; for during a recent service at the Maternity Hospital I was careful to note every case in the early puerperium in which a distinct vesical tumour was observed, and without a single exception the vesical tumour was to the right and the uterus to the left. To be exact, out of 38 puerpera observed, there were 9 cases of distinct vesical tumour, all which were right. Now, there are various causes at work in causing these lateral deflections of the uterus. That it is the bladder which displaces the uterus, of course, there is no doubt, for I have just shown that with an empty bladder the uterus is central. In the first place, I believe in many cases they are accidental. As I have already hinted, the right lateral deviation of the uterus admits of ready explanation in the previously-existing deviation during pregnancy, and probably a loaded condition of the rectum may be a factor in right uterine deviation.

But what explanation is to be offered of left deviation?

This lateral displacement of the uterus by the distending bladder is matter for study. The mechanism I take to be as follows:—As the bladder fills the fundus uteri is raised by being thrown from the abdominal wall. It then falls to the right side, not, as I believe, owing to the bladder pressing it to that side, but—1st, from its natural lie in that direction obtained during pregnancy; 2d, owing to some extent to the influence of the rectum; 3d, it may be from the accident of position.

The bladder post-partum naturally tends to expand towards the right side rather than to left; and if the influence of the bladder were the only factor at work in displacing the uterus, this organ would deviate more to the left than the right. There seems to me to be two reasons for this.

1*st*, The female bladder is marked by lateral asymmetry. In support of this I may recall the observations made by Barkow:—Out of 35 bladders of adult women, in 10 the asymmetry was minor; in 21 the asymmetry was major; out of the 35 only 4 were completely symmetrical.

The asymmetry is much more marked on the right than on the left. Barkow found, right 18; left 8.

This asymmetry, though characteristic of the female bladder generally, is so constantly present in the bladders of parous women that it may be regarded as the normal condition.

There is a fallacy, however, in assuming that a bladder will distend when removed from the body, or even in the body after the other viscera have been removed, in the same way as it would in the closed abdominal cavity. For instance, in a section of a female pelvis of a girl æt. 18 by Legendre, to which I have already referred, he shows the bladder distended not as one would expect in a young girl. Braune, referring to this, mentions that it probably arose from the bladder being distended after the viscus was removed.

2*d*, The right lateral expansion of the bladder immediately after labour is favoured by the condition of matters ante-partum. Thus the bladder is flattened under the anterior and lower segment of the uterus, and if careful sounding of the bladder is made it will be found, as I have shown elsewhere, that while little space is left on the left side, the bladder is free on the right, owing, no doubt, to the preponderance of L.O.A. position. It seems to me that if the uterus were a perfectly free body, not biassed by any deviation to one side or another, the effect of the filling of the bladder would be first to raise it, and then to deflect it to the left.

I have made four experiments in women in whom, during pregnancy, there was NO lateral deviation to be noted, and in whom the position of the pelvis was as nearly horizontal, and in each the uterus, with an empty bladder, was central. In each case the *uterus*, with full bladder, was *left* and *bladder* tumour *right*. In each, the uterus during pregnancy was central. On the morning of the third day with the bladder and rectum empty, and the patient supine, uterus was central. On the fourth day, Case 1.—Distinct vesical tumour; direction upwards and to *right;* uterus pushed to *left* ½ inch above umbilicus; twenty ounces of urine drawn off; vesical tumour disappeared; uterus sank two inches below umbilicus and became *mesial.* Case 2.—Ovoid vesical tumour 1 inch above umbilicus; main portion to *right;* uterus to *left;* 30 ounces of urine drawn off; uterus *mesial.* Case 3.—Distinct bladder tumour extending to *right* side 1½ inch above the level of umbilicus; uterus to *left* and back; 28 ounces of urine drawn off; uterus *mesial.* Case 4.—Distinct vesical tumour 1½ inch above umbilicus; lies to *right* of mesial line; uterus to *left;* 32 ounces of urine drawn off; uterus *central.* Obs. 2, Case 4.—Vesical tumour extending 1 inch above umbilicus; main portion to *right;* uterus to *left;* 25 ounces urine drawn off; uterus *central.*

It seems to me, then, that normally the uterus in the early puerperium, under the conditions mentioned—viz. an empty bladder and rectum and the horizontal position—is central; that when the bladder is full the uterus is deflected either to the right or left side. If to the right side, the deflection is due, 1*st*, to a previously existing right lateral deviation during pregnancy; 2*d*, to the presence of a loaded rectum; 3*d*, to the accident of position. If to the left side, it is mainly due, 1*st*, to the filling of the bladder, which, for the reasons mentioned, expands to the right; or, 2*d*, to the left lateral decubitus of the patient.

It is to be further observed that these displacements are more common in the early than in the late puerperium.

1*st*, Because more urine is secreted in the early than the late puerperium, and therefore the bladder gets more rapidly distended. Gassner has shown that increased diuresis is the normal condition during the puerperium, and both this author and Winckel distinctly show that the increase is most marked in the first days after delivery.

2*d*, Because retention of urine is more common in the early days of the puerperium.

3*d*, The uterus becomes less mobile as the puerperium advances.

It is matter of clinical observation that in many cases the puerperal uterus rotates round its central axis, so that, in fact, the transverse axis of the uterus no longer corresponds to the transverse diameter of the pelvis. One side of the uterus is thrown forwards, with the result that the transverse axis of the uterus corresponds to the oblique diameter of the pelvis. This occurs apart from any repletion of the bladder, and is recognised during pregnancy when the anterior surface of the uterus looks to the right, so that the transverse axis of the fundus is in the right oblique diameter of the pelvis.

Out of 64 cases noted by Börner, in 50 rotation was totally absent—both sides of the uterus being on the same plane, the transverse axis of the uterus corresponding to the transverse axis of the pelvis. In 12 there was distinct rotation to the right side, and in two rotation to the left. This rotation of the uterus is specially well marked in cases where the bladder is distended, and it occurs with distension of the bladder, in cases where it is absent, where the viscus is empty. If the rotation, apart from the filling viscus, be to the right, then when it is full it is more marked in that direction, and *vice versa.* It is worthy of note that the filling of the bladder never causes rotation in an opposite direction. Pfannkuch remarks that "sometimes when the bladder is very full one can observe a rotation of the uterus in the sense that the lateral edge is turned round towards the front." In the cases I have recorded this rotation has been distinctly remarked to the extent that out of 40 cases which have been noted, in 10, apart altogether from bladder relations, the rotation to the right was marked; and in those cases where the bladder was full the rotation has been noted twice.

We now come to look at the quantity of urine required to produce these three definite alterations in the post-partum uterus, viz.—1. Displacement upwards and backwards; 2. Displacement laterally; 3. Rotation. I have found that from 20 to 30 oz. of urine are sufficient to bring about the upward and lateral displacements of the uterus. From 8 to 15, I have found, make but very little appreciable difference. Pfannkuch says that 100 cc. of urine—*i.e.* 3.5 oz.—raise the uterus, on an average, about 1 cm., that is, ⅓ inch.

Autefage says that with a bladder full, of from 400 to 600 grammes of urine, nothing is more common, the day after accouchement, than to observe an augmentation of the real height of the uterus, which is not less than from 4 to 9 cm., 1⅓ to 3 in. Once he found 3 to 9, usually 5 cm. = 1⅔ inches. Now, on comparing these figures with each other, the results will be found to be very different, and the explanation will be found in the fact that the observations were made in different periods of the puerperium. I have already shown that this is important, because the displacing influence of the bladder on the uterus proportionately diminishes as the puerperium advances, and I need not again here refer to the reason for this. At present I refer to the early puerperium, and here I mean to state that an amount of urine varying from 20 to 30 oz. is necessary to bring about the position changes in the uterus to which I have referred; that, further, the relative amount of position change is *more* marked with 25 oz. than with the largest quantities; or, in other words, that the displacement of the uterus does not, after a certain point has been reached, bear a direct proportion to the repletion of the bladder. For example, the displacement changes, upwards, laterally, and transversely, while distinctly marked with 25 oz., will not be *proportionately* increased with 50 oz.

APPENDIX.

In order to corroborate the results of the experiments upon bladder pressure during labour, which I have recorded in the foregoing sections, I undertook a set of fresh experiments.

The first set of experiments were conducted with a manometer without any self-recording apparatus, consequently while every care and attention were bestowed on the observation and record of the various gradations of the mercury, still it was impossible to note every detail with the accuracy obtainable by the graphic method.

In the former set of observations the object was to ascertain the amount of pressure lost upon the bladder during the process of parturition by noting the exact rise of the mercurial column during pains at various intervals during the first and second stages of labour.

Thus, while definite knowledge was obtained as to the maximum pressure exerted by individual parturient efforts at different periods of labour, yet no clear idea was arrived at as to the gradation through which the mercurial column passed during the continuance of each parturient effort.

In order to investigate the subject the simple manometer was fitted with a recording style, writing on a drum. The apparatus was the same in every respect as formerly, the drum only being added. The tracings shown were taken by transfer paper from the original tracings on the drum.

It will be seen from the tracings shown how thoroughly the more reliable graphic method of observation confirms the previous observation.

Thus taking 12 of the highest readings out of 6 tracings obtained during the second stage and striking an average, the result is exactly 3·2 inches mercury.

This entirely corresponds to the maximum readings in the former observations.

Further, taking an average of 9 of the maximum readings in the first stage, we find that ·52 represents the average high readings during the first stage. In my former experiments the figure was ·42.

In the first stage there is always room for slight variation, owing to voluntary efforts being interjected, and so destroying the averages.

Now on looking at these tracings more closely it will be observed that each of the tracings exhibited graphically represents *an individual parturient effort*, so far at least as that effort is expended on the urinary bladder. The exact period over which the pain extended can be accurately noted by observing the time occupied by the revolution of the drum, and this I find varied from 19 to 39 seconds. Out of 10 graphic tracings the average duration was 26 seconds. The average duration of a wavelet is 3. A pain therefore is a succession of parturient efforts interrupted by appreciable periods of rest. Such a pain comes to be the sum of a series of fractional efforts on the part of the expulsive powers, while the labour is the sum of these pains.

A glance at those tracings shows very distinctly the relative difference between the first and second stages of labour—the trace waves becoming more and more distinct as the labour advances. Further, it is worthy of remark that although we would naturally expect that the fractional efforts would lead up to a point of maximum intensity, yet these tracings do not support this assumption. For it will be seen that the acme of a pain is not represented by a wave of maximum intensity, but by a series of waves of nearly the same intensity. I may further call attention to the fact that the wavelets on the curve are merely the results of oscillations of the mercurial column, and are common to all tracings obtained in this way. In looking for an explanation of the cause of these waves several possibilities suggest themselves.

1st. There can be no possible doubt that they are caused in the main by the interrupted compression of the fluid cushion of the bladder, between the abdominal and respiratory muscles, and the solid outlines of the uterine tumour.

2d. It seems certain that the larger waves correspond in the first stage of labour to interjected voluntary efforts, and in the second stage are explained by tension of the abdominal walls, the glottis being closed. This tension is coincident with a uterine pain, which acting reflexly on the abdominal muscles excites them to action, thus compressing the bladder between them and the uterus. This may or may not be associated with full inspiration, because on making the patient take a deep inspiration or strain, the rise in the manometer is trifling. The fall in the wave is coincident with the opening of the glottis, which is of course followed by relaxation of the abdominal walls.

3d. We must also take into account the fact that some of the smaller waves are in all probability caused by alterations in the uterine ovoid, communicated to the manometer through the bladder compressed against the rigid abdominal walls. Such smaller waves occur during the continuance of the larger waves.

4th. It is possible, although difficult to prove with certainty, that some of the smaller waves may be due to contractions of the bladder itself brought about by "irradiation of impulse" from the uterine centre—that is to say, an impulse starting from the uterus reaches the cord, and in virtue of its intensity and the proximity of the bladder centre, excites not only the uterine motor centre, but that of the bladder as well.

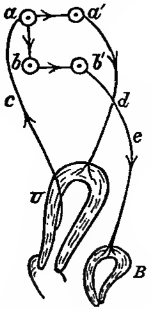

FIG. 15.
U uterus, B. bladder.
a, *a′* reflex centre for uterus in cord.
b, *b′* reflex centre for bladder in cord.
c afferent nerve from uterus.
d efferent nerve to uterus.
e efferent nerve to bladder.

The issue of the matter simply amounts to this, that whatever subsidiary factors may be at work in producing these graphic waves, the larger of them at least are the result of the compression of the bladder walls by the intermittently stimulated abdominal walls against the rigid uterine wall, keeping in view always that the uterus is in a condition of contraction, *i.e.* during a uterine pain.

One of these graphic tracings will be found in *facsimile* at the end of the tables.

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MANOMETRIC OBSERVATIONS O

No. of Patient	No. of Observ.	Name	Age	No. of Labour	Pains commenced		Examined		Condition of Os.	Condition of Membranes
					Day	Hour	Day	Hour		
1	1	Mary Cattart	22	I	Aug 30	2 p.	Aug 30	7 p.	Dilated	Unruptured
	2									Ruptured
2	3	Mrs. Tait	37	II		6.15 p.		11.25 p.	Dilated	Unruptured
3	4	Helen Hutchison	30	I	„ 23	4 a.	„ 23	12 n.	Crownpiece	Unruptured
4	5	Eliza Chalmers	16	I		10.45 a.		1.15 p.	Crown	Ruptured
5	6	Ann Burns		I	Sept. 6		Sept. 6	11.30 a.	Dilated	Ruptured
	7									
6	8	Margaret Campbell		I			„ 13	12.20 a.	Crown	Ruptured
	9								Dilated	
7	10	Bridget McGratt		I	„ 21	1 a.	„ 21	1.45 a.	Florin	Ruptured
	11								Dilated	
8	12	Helen McAra		I	„ 22	9 a.	„ 23	6 a.	Florin	Unruptured
	13									
9	14	Janet Burton	17	I	„ 24	7 p.	„ 24	12.30 a.	Dilated	Unruptured
	15								Crown	Ruptured
10	16	Mary Steven	23	I	„ 30	11 p.	Oct. 1	11 a.	Dilated	Ruptured
	17								Dilated	
11	18	Mary Munroe	20	I	Octr. 1	6 a.	„ 1	2.50 p.	Dilated	Ruptured
12	19	Susan Wright	79	I				4.35 p.	Crown	Ruptured
13	20	Margaret Taylor	27	I	„ „	12 n.		7.15 p.	Wineglass	Unruptured
	21								Dilated	Unruptured
	22								Florin	Ruptured
14	23	Mrs. Hamilton	29	II	„ 3	10.30 a.	„ 3	4.30 p.	Florin	Unruptured
15	24	Laurina Urquhart	23	I	„ 3		„ 4	3 a.	Dilated	Ruptured
	25								Dilated	Ruptured
16	26	Mary Dawson	22	II	„ 4	3 a.	„ 4	5 a.		Unruptured
	27								Shilling	
17	28	Robina Stevenson	27	I	„ 3	9 p.	„ 4	8 p.	Shilling	Ruptured
18	29	Margaret Currie	21	II	„ 4	8 p.	„ 5	6 a.		Unruptured
	30								Dilated	Unruptured
	31								Dilated	Ruptured
19	32	Jane Cran	29	II	„ 3	3 p.	„ 5	8.15 a.	Dilated	Ruptured
20	33	Isabella Oliver	34	II	„ 8	3 p.	„ 8	10.45 p.	Dilated	Unruptured
21	34	Catherine Wardlaw	20	II	„ 9	8 p.	„ 9	8 p.		Unruptured
	35								Dilated	Unruptured
22	36	Mrs. Staid	23	II		10.30 p.		10.45 p.	Dilated	Unruptured
28	37	Eliza Wilson	20	I	„ 21	9 p.	„ 22	9.50 a.	Florin	Ruptured
24	38	Jane Stevenson	20	I	„ 28	7 a.	„ 28	12.30 p.	Dilated	Unruptured
25	39	Lizzie Purves	19	II	„ 28	12 p.	„ 29	7.25 a.	Dilated	Unruptured

MENT OF
LADDER DURING PARTURITION.

ion ion	Situation of Head	Limits of Observation		Minutes	Number of Observns	Mercury in Interval	Minm Rise during pain	Time of Minm Rise	Maxm Rise during pain	Time of Maxm Rise	Urine Oz:-
		From	To								
	Cavity	7·20	7.30	10	4	·2	·3	7·20	·9	7·25	
		10·45	10·55	10	2		2·4	10·55	2·6	10·45	
	Cavity					·2			·2		
	Cavity				9	·2	·6	12·5	2·7		14
		11.30	12·	30	8	·2	·4	11:30	·9	11·50	
	Outlet				5		1·9	1·	2·4		
									·3		
	Outlet	4·40	5.25	45	11	·2	·1	4·	·5	5·10	3
		2.30	2.45	15	5	·2	·1	2·42	·5	2·45	
	Outlet	11.17	11.37	20	6	·3	2·5	11·17	·5	11·25	
		12.30	1.10	40	6	·2	·2	12·30	1·5		
	Outlet				5	·8	·8	5·16	1·5	5·16	
		11.15	11.22	7	4	·5	·1	11·15	·3	11·20	10
	Cavity	7. 7	7.30	23	7	·2	·4	7·7	·6	7·20	½
	Cavity	2. 50	3.16	26	7	·2	·4	2·50	1·6	3·12	2½
	Cavity	4. 35	4.43	8	6	·2	1·4	4·35	2·4	4·40	½
	Cavity	7. 20	7.30	13	5	·2	2·5	7·23	3·0	7·29	2
		11. 10	11.27	17	6	·1	1·5	11·10	2·5	11·13	
		11. 30	11.43	13	5	·2	2·5	11·35	3·2	11·35	2
	Cavity	4. 45	5.12	27	5	·2	·3	4·50	·5	5·0	
	Cavity	3. 2	3.18	16	5	·3	·3	3·2	2·5	3·13	6
	Cavity	4. 5	4.17	12	5	·3	1·	4·5	2·3	4·13	
	Cavity	5. 5	5.20	15	2	·2	·3	5·10	·6	5·18	1
	Outlet	6. 30	6.32	2	3	·2	1·0	6.30	2·0	6·32	
	Brim	8. 20	8.30	10	3	·2	·1	8·20	·1	8·30	6
	Brim	6.20	6.25	5	3	·5	·2	6·23	·4	6·20	1
	Brim	12.50	1·	10	9	·3	·3	12·50	·3	1.0	3
	Cavity	4.52	5.17	25	9	·3	·6	4·52	2·3	5·14	½
	Outlet	8.25	8.32	7	4	·6	·6	8·30	2·0	8·32	
	Cavity	10.45	11.2	17	5	·3	·2	10·45	3·0	11·2	1
		11. 33	11. 4	7	5	·2	·3	11.33	·6	11·39	½
		11.50	12·	10	8	·2	1·2	11·50	2·5	11·59	
	Cavity	10.45	10.52	7	5	·2	1·2	10·45	2·3	10·52	2
	Outlet	9.50	9.56	6	4	·4	1·2	9·50	1·8	9·52	
	Brim	12.50	1. 8	18	6	·2	1·2	1·2	·5	1·8	10
	Cavity					·3	1·5		2·0		

TABL

MANOMETRIC OBSERVATION

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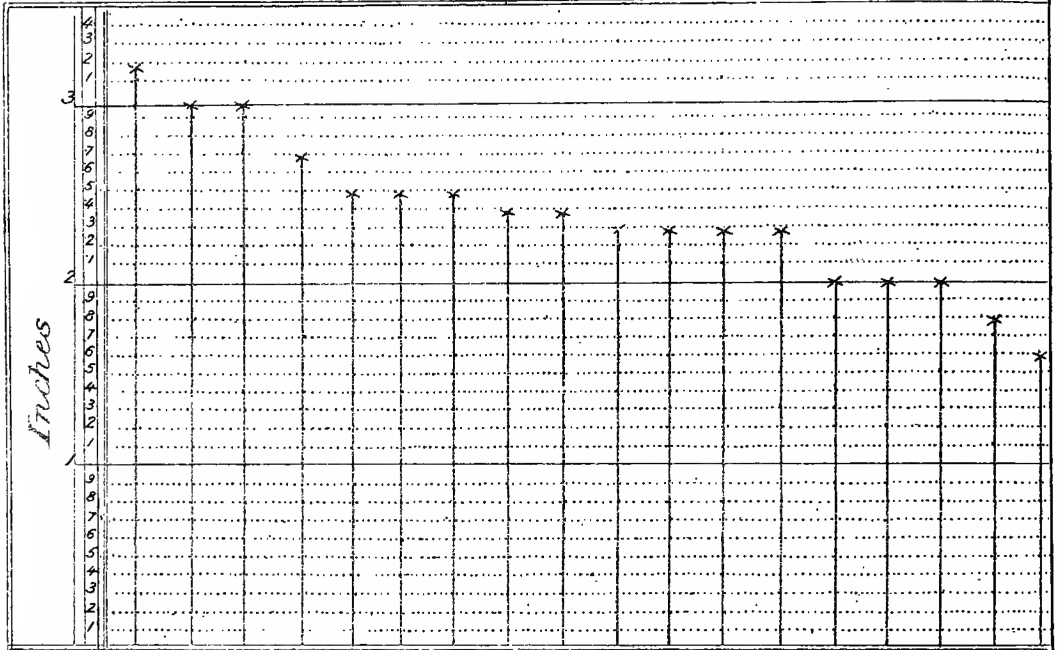
Amount of Pre



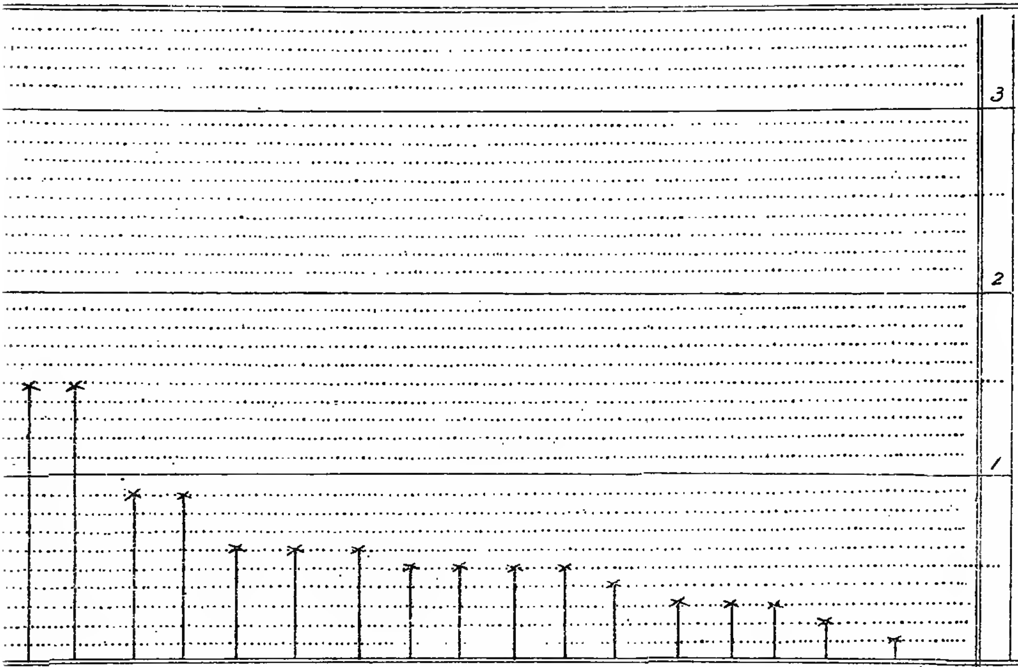
URINE	2	2	1	14		2			½	6		½	2					2½
SITUATION OF HEAD	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Outlet	Cavity	Cavity	Outlet	Cavity	Cavity	Cavity	Outlet	Cavity	Outlet	Cavity
PRESENTATN AND POSITION	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. ROP	V. LOA	V. ROP	V. ROP	V. ROP	V. LOA	V. ROP	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA
CONDITION OF MEMBRANES	Ruptured	Unruptd	Unruptd	Ruptured	Ruptured	Unruptd	Unruptd	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Unruptd	Unruptd	Ruptured	Unruptd	Ruptured	Ruptured
CONDITION OF OS	Dilated	Crown	Dilated	Crown	Dilated	Dilated	Dilated	Dilated	Dilated	Flown	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated
Nº OF LABOURS	I	I	II	I	I	I	II	I	I	I	I	II	II	II	II	II	I	I
AGE	27	27	34	16	22	27	20		19	23	23	21	23	22	29	19	20	20
Nº OF OBSERVN	22	20	33	5	2	21	35	7	19	24	25	31	36	27	32	39	37	18

II.

ON THE BLADDER IN PARTURITION

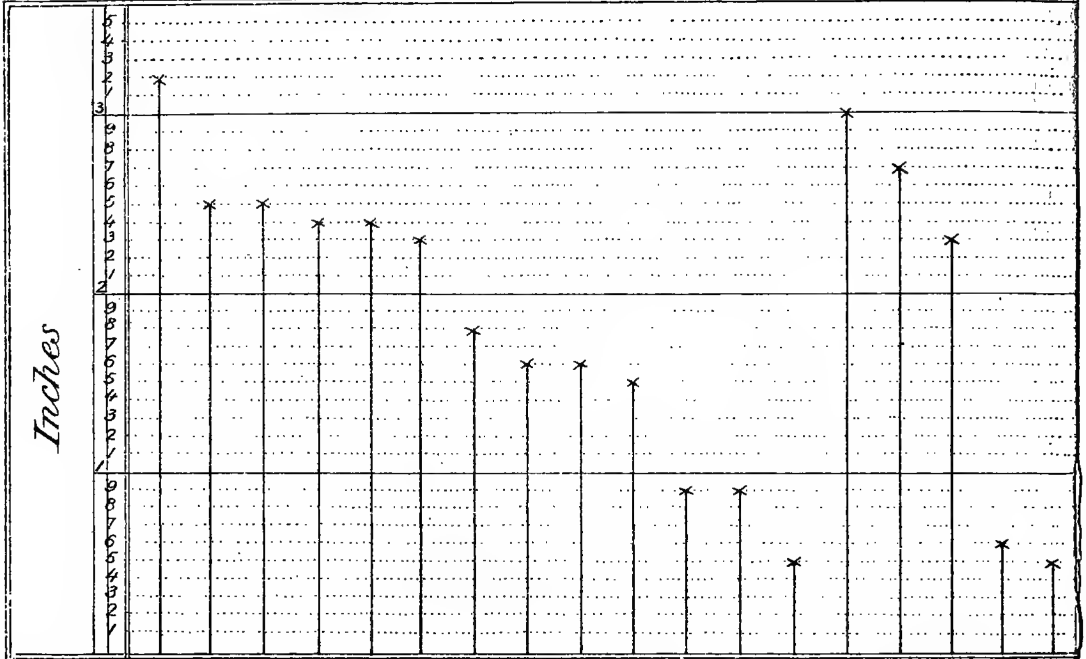
RDING TO

ure Indicated!



				½	1	½	3			10	1		10	3		6
	Outlet	Cavity	Cavity	Cavity	Cavity	Cavity	Outlet		Cavity	Brim	Brim	Cavity	Cavity	Brim	Cavity	Brim
V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. ROP	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. ROP	V. LOA
Unruptd.	Ruptured	Unruptd.	Ruptured	Ruptured	Unruptd.	Unruptd.	Ruptured	Ruptured.	Unruptd.	Unruptd.	Unruptd.	Ruptured	Ruptured.	Unruptd.	Unruptd.	Ruptured
Dilated	Dilated	Dilated	Dilated	Wineglass	Dilated	Dilated	Dilated	Crown	Florin	Florin	Shilling	Florin	Crown	Shilling	Crown	Shilling
I	I	I	I	I	II	II	I	I	II	I	II	I	I	II	I	I
17	16	22		23	22	20			29	20	21		23	21	30	27
14	15	1		17	26	34	9	10	23	38	29	8	16	30	4	28

TABL
MANOMETRIC OBSERVATIONS
ARRANGED
Stage and N



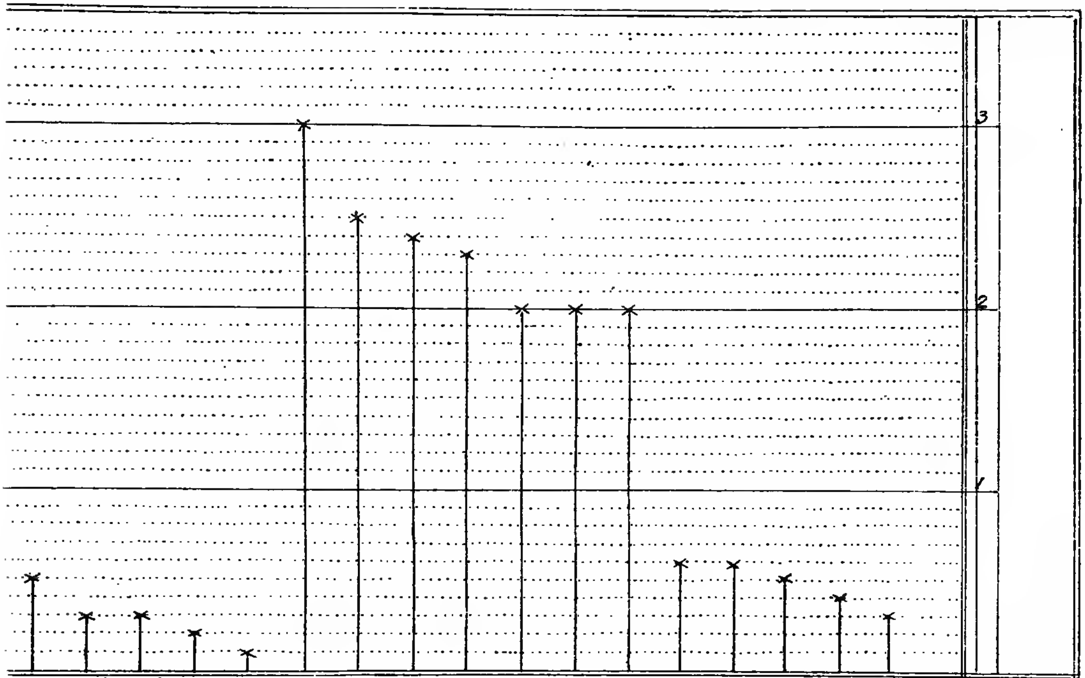
URINE	2		2		½			2½						2	14	6	½	
SITUATION OF HEAD	Cavity	Cavity	Cavity	Outlet	Cavity	Outlet	Outlet	Cavity	Cavity	Outlet	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	
PRESENTATN and POSITION	V. LOA	V. LOA	V. LOA	V. LOA	V. ROP	V. ROP	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. ROP	V. LOA	V. LOA
CONDITION OF MEMBRANES	Ruptured	Ruptured	Unruptd	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Unruptd	Ruptured	Ruptured	Ruptured	Ruptured	Unruptd	Ruptured	Ruptured	Ruptured	Ruptured
CONDITION OF OS	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Crown	Crown	Florin	Wineglass	Crown
No of LABOURS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
AGE	27	22	27		19	23	20	20	17	16	22			27	16	23	23	
No of OBSERVn	22	2	21	7	19	25	37	18	14	15	1	6	9	20	5	24	17	10
	DILATED PRIMIPARAE													UNDILATED				

E III.

ON THE BLADDER IN PARTURITION

CCORDING TO

mber of Labours.



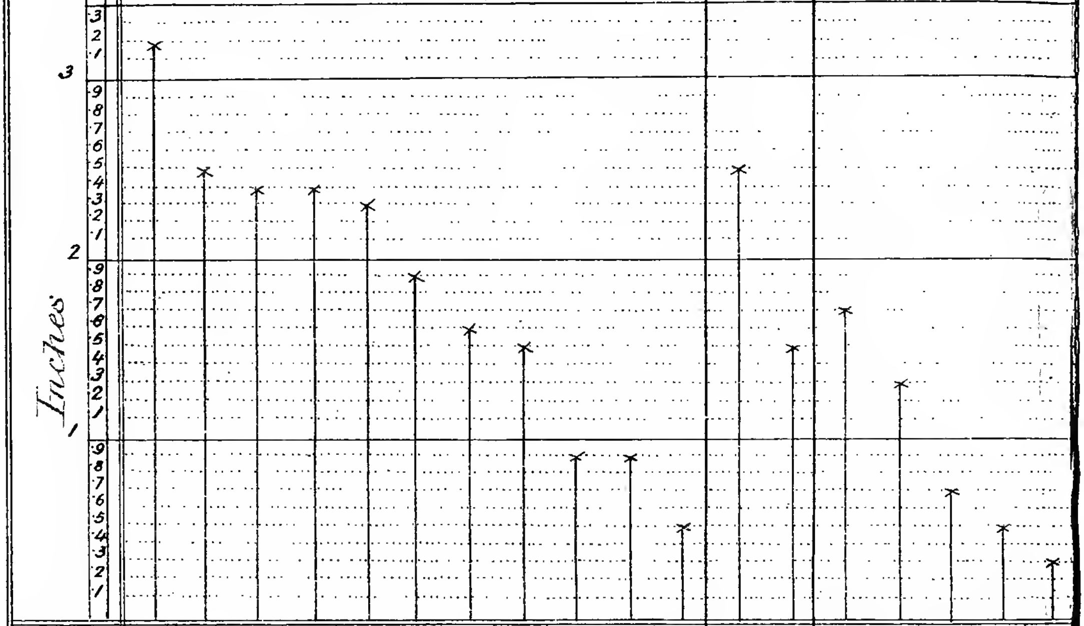
10		10		6	1		1/2	2				1	1/2		1	3
Brim	Cavity	Cavity	Cavity	Brim	Cavity	Cavity	Cavity	Cavity	Cavity	Outlet	Cavity	Cavity	Cavity	Cavity	Brim	Brim
V. LOA	V. LOA	V. LOA	V. ROP	V. LOA	V. LOA	V. ROP	V. LOA	V. ROP	V. LOA	V. LOA	V. LOA	V. LOA	V. ROP	V. LOA	V. LOA	V. LOA
Unruptd	Ruptured	Ruptured	Unruptd	Ruptured	Unruptd	Unruptd	Ruptured	Unruptd	Unruptd	Ruptured	Unruptd	Unruptd	Unruptd	Unruptd	Unruptd	Unruptd
Florin	Florin	Crown	Crown	Shilling	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Florin	Shilling	Shilling
I	I	I	I	I	II	II	II	II	II	II	II	II	II	II	II	II
20		23	30	27	34	20	21	23	22	29	19	22	20	29	21	21
38	8	16	4	28	33	35	31	36	27	32	39	26	34	23	29	30
RIMIPARAE					DILATED MULTIPARAE									UNDILTD MULTIP.		

TABL

MANOMETRIC OBSERVATIONS

ARRANGED A

Number of Labours and Con



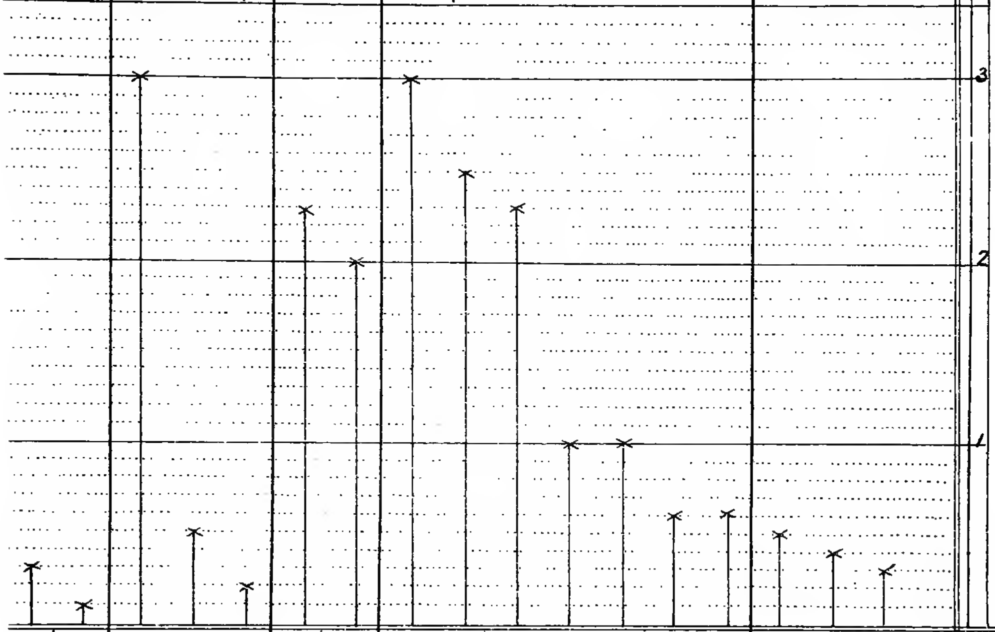
	Primiparae - Dilated - Ruptured											Primiparae Dilat-Unruptd		Primiparae-Undilated-Ru				
URINE	2			1/2			2 1/2					2		14	6	1/2		
SITUATION of HEAD	Cavity	Cavity	Outlet	Cavity	Outlet	Outlet	Cavity	Outlet	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity		Cavity
PRESENTATn and POSITION	V. LOA	V. LOA	V. LOA	V. ROP	V. ROP	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. ROP	V. ROP	V. ROP.	V. ROP
CONDITION OF MEMBRANES	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured	Unruptd	Unruptd	Ruptured	Ruptured	Ruptured	Ruptured	Ruptured
CONDITION OF OS	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Crown	Florin	Wineglass	Crown	Florin
No. of LABOURS	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I	I
AGE	27	22		19	23	20	20	16	22			27	17	16	23	23		
No. of OBSERVn	22	2	7	19	25	37	18	15	1	6	9	21	14	5	24	17	10	8

E IV

ON THE BLADDER IN PARTURITION.

CCORDING TO

dition of Os and Membranes.



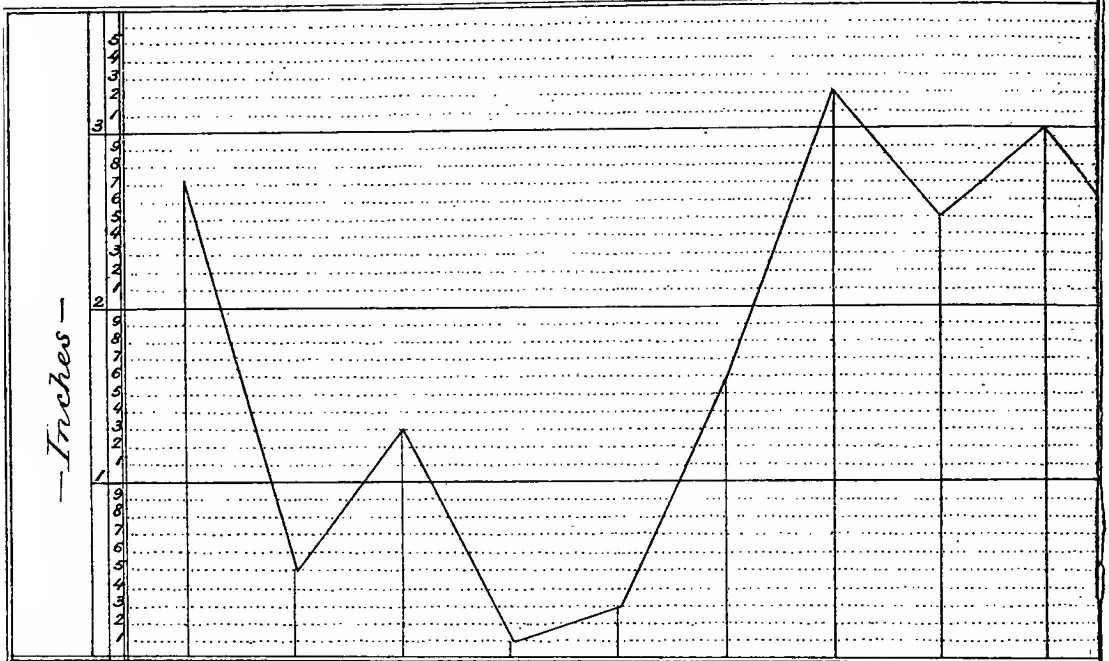
ptured		Primiparae Undilat'd-Unrupt'd			Multiparae Dilat.-Ruptured		Muliparae Dilated-Unruptured							Multiparae Undil.-Unrup.		
	6	2	10		1/2		1		2			1	1/2		1	3
Cavity	Brim	Cavity	Brim	Cavity	Cavity	Outlet	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Cavity	Brim	Brim
V. LOA	V LOA	V. LOA	V LOA	V. ROP	V LOA	V. LOA	V. LOA	V ROP	V. ROP	V. LOA	V. LOA	V LOA	V. ROP	V LOA	V. LOA	V LOA
Ruptured	Ruptured	Unrupt'd	Unrupt'd	Unrupt'd	Ruptured	Ruptured	Unrupt'd	Unrupt'd	Unrupt'd	Unrupt'd	Unrupt'd	Unrupt'd	Unrupt'd	Unrupt'd	Unrupt'd	Unrupt'd
Crown	Shilling	Crown	Florin	Crown	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Dilated	Florin	Shilling	Shilling
I	I	I	I	I	II	II	II	II	II	II	II	II	II	II	II	II
23	27	27	20	30	27	29	34	20	23	22	19	22	20	29	21	21
16	28	20	38	4	31	32	33	35	36	27	39	26	34	23	29	30

TABL

MANOMETRIC OBSERVATIONS O

ARRANGED ACC

Quantity of Uri



URINE	14	10	6	6	3	2½	2	2	2
SITUATION OF HEAD	Cavity	Brim	Cavity	Brim	Brim	Cavity	Cavity	Cavity	Cavity
PRESENTATN AND POSITION	V. LOA	V. LOA	V. ROP	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA	V. LOA
CONDITION OF MEMBRANES	Ruptured	Unruptd	Ruptured	Ruptured	Unruptd	Ruptured	Ruptured	Unruptd	Unruptd
CONDITION OF OS	Crown	Florin	Florin	Shilling	Shilling	Dilated	Dilated	Dilated	Crown
No of LABOURS	I	I	I	I	II	I	I	I	I
AGE	16	20	23	27	21	20	27	27	27
No of OBSERVN	5	38	24	28	30	18	22	21	20

E V.

THE BLADDER IN PARTURITION.

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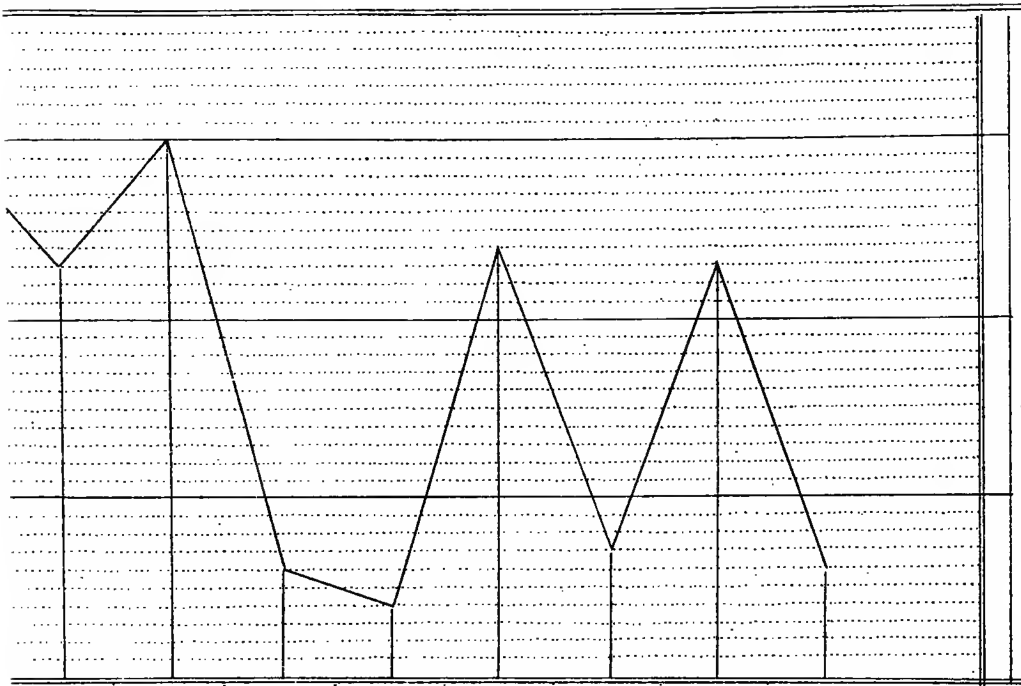
e in the Bladder.



2	1	1	1	½	½	½	½
Cavity	Cavity	Cavity	Brim	Cavity	Cavity	Cavity	Cavity
V. ROP	V. LOA	V. LOA	V. LOA	V. ROP	V. LOA	V. LOA	V. ROP
Interruptd	Interruptd	Interruptd	Interruptd	Ruptured	Ruptured	Ruptured	Interruptd
Dilated	Dilated	Dilated	Shilling	Dilated	Wineglass	Dilated	Dilated
II	II	II	II	I	I	II	II
23	34	22	21	19	23	21	20
36	33	26	29	19	17	31	34

No. of Observn.	Age	No. of Labours	Condition of Os	Condition of Membranes	Presentatn and Position	Situation of Head	Urine
20	27	I	Crown	Unruptd	V. LOA	Cavity	2
5	16	I	Crown	Ruptured	V. LOA	Cavity	14
24	23	I	Florin	Ruptured	V. ROP	Cavity	6
17	23	I	Wineglass	Ruptured	V. LOA	Cavity	½
10		I	Crown	Ruptured	V. LOA		
38	20	I	Florin	Unruptd	V. LOA	Brim	10
8		I	Florin	Ruptured	V. LOA	Cavity	
16	28	I	Crown	Ruptured	V. LOA	Cavity	10
4	30	I	Crown	Unruptd	V. ROP	Cavity	
28	27	I	Shilling	Ruptured	V. LOA	Brim	6

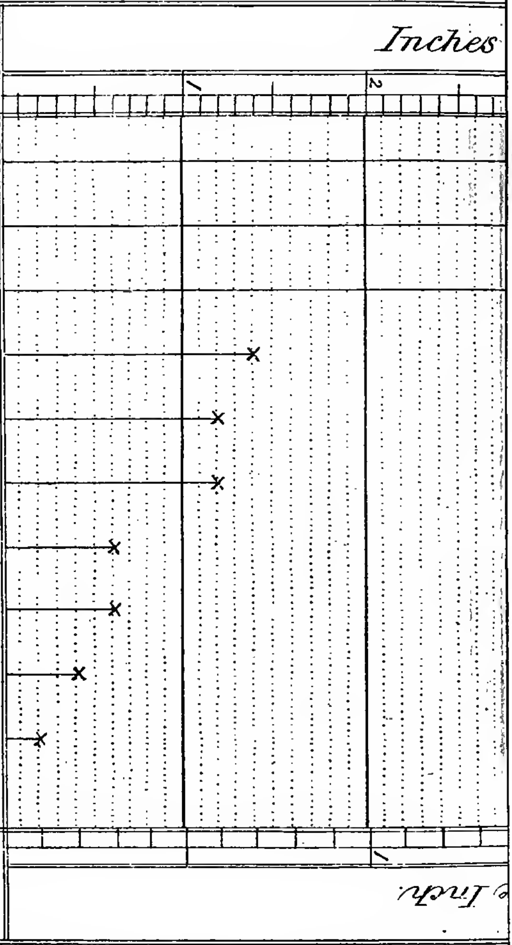
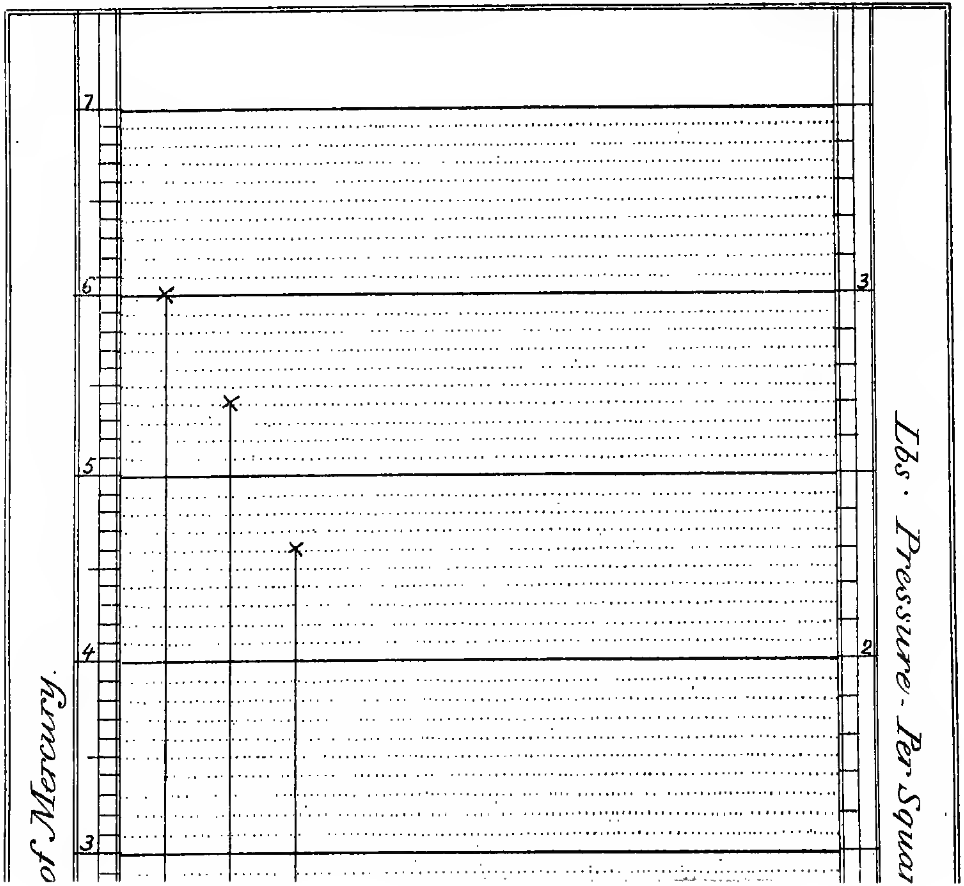


TABLE VI.

MANOMETRIC OBSERVATIONS ON THE BLADDER IN PARTURITION.

Shewing Pressure per Square Inch of Bladder Area.

A. *Undilated Primiparae.*



No. of Observn	Age	No. of Labours	Condition of Os	Condition of Membranes	Presentation and Position	Situation of Head	Urine
33	27	I	Dilated	Ruptured	V. LOA	Cavity	2
35	22	I	Dilated	Ruptured	V. LOA	Cavity	
31	27	I	Diluted	Unruptd	V. LOA	Cavity	2
36		I	Dilated	Ruptured	V. LOA	Outlet	
27	19	I	Dilated	Ruptured	V. ROP	Cavity	½
32	23	I	Dilated	Ruptured	V. ROP	Outlet	
39	20	I	Dilated	Ruptured	V. LOA	Outlet	
26	20	I	Dilated	Ruptured	V. LOA	Cavity	2½
34	17	I	Dilated	Unruptd	V. LOA	Cavity	
23	16	I	Dilated	Ruptured	V. LOA	Outlet	
29	22	I	Dilated	Ruptured	V. LOA	Cavity	
30		I	Dilated	Ruptured	V. LOA	Cavity	
		I	Dilated	Ruptured	V. LOA	Cavity	

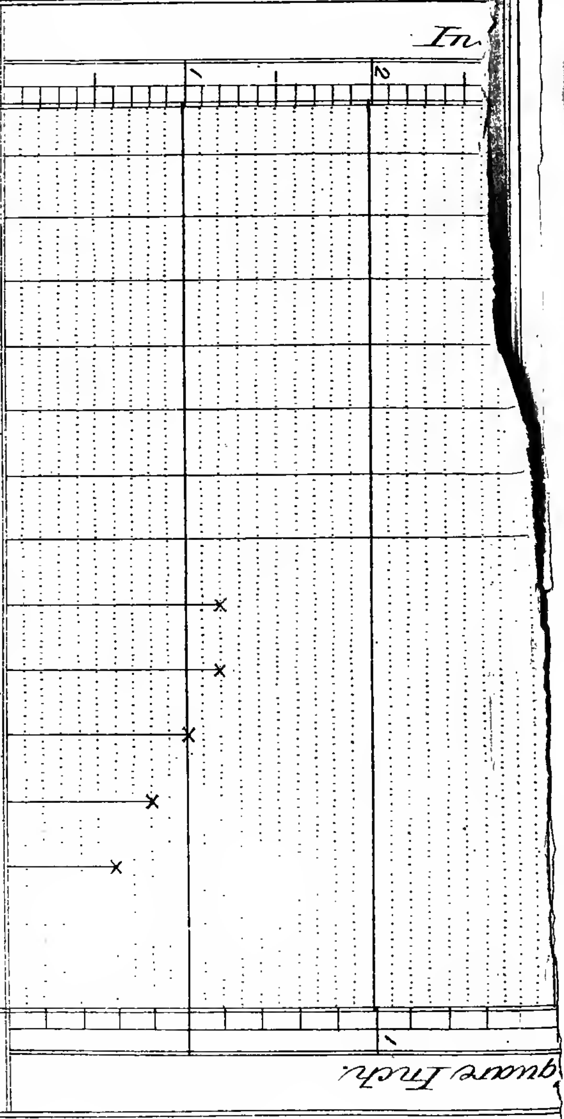
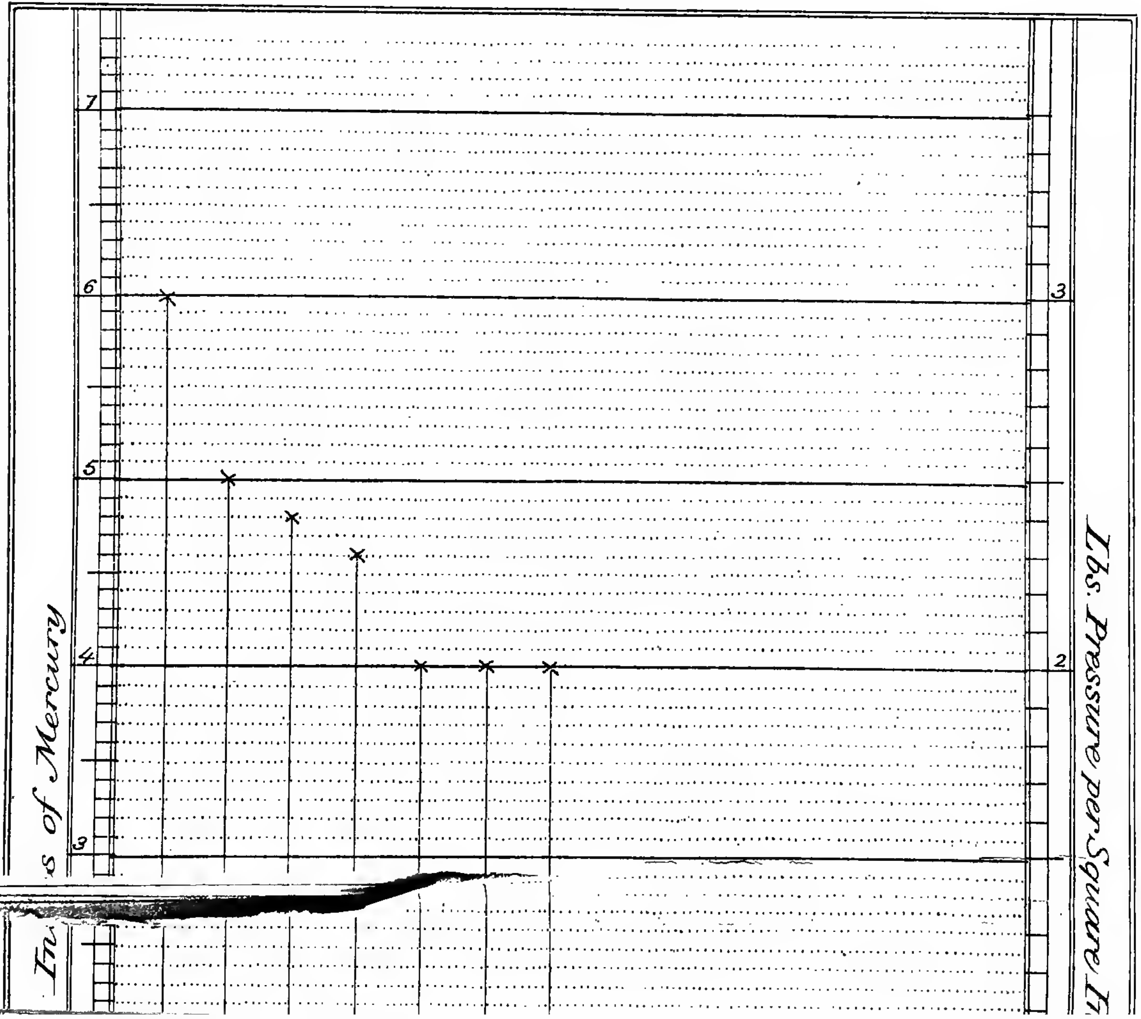


TABLE VII.

MANOMETRIC OBSERVATIONS ON THE BLADDER IN PARTURITION.

Showing Pressure per Square Inch of Bladder Area.

B. *Dilated Primiparae.*



No. of Observn	AGE	No. of Labours	CONDITION OF OS	CONDITION OF MEMBRANES	PRESENTATN AND POSITION	SITUATION OF HEAD	URINE
	34	II	Dilated	Unruptd	V. LOA	Cavity	1
	20	II	Dilated	Unruptd	V. ROP	Cavity	
	21	II	Dilated	Ruptured	V. LOA	Cavity	1/2
	23	II	Dilated	Unruptd	V. ROP	Cavity	2
	22	II	Dilated	Unruptd	V. LOA	Cavity	
	29	II	Dilated	Ruptured	V. LOA	Outlet	
	19	II	Dilated	Unruptd	V. LOA	Cavity	
	22	II	Dilated	Unruptd	V. LOA	Cavity	1
	20	II	Dilated	Unruptd	V. ROP	Cavity	1/2
	29	II	Florin	Unruptd	V. LOA	Cavity	
	21	II	Shilling	Unruptd	V. LOA	Brim	1
	21	II	Shilling	Unruptd	V. LOA	Brim	3

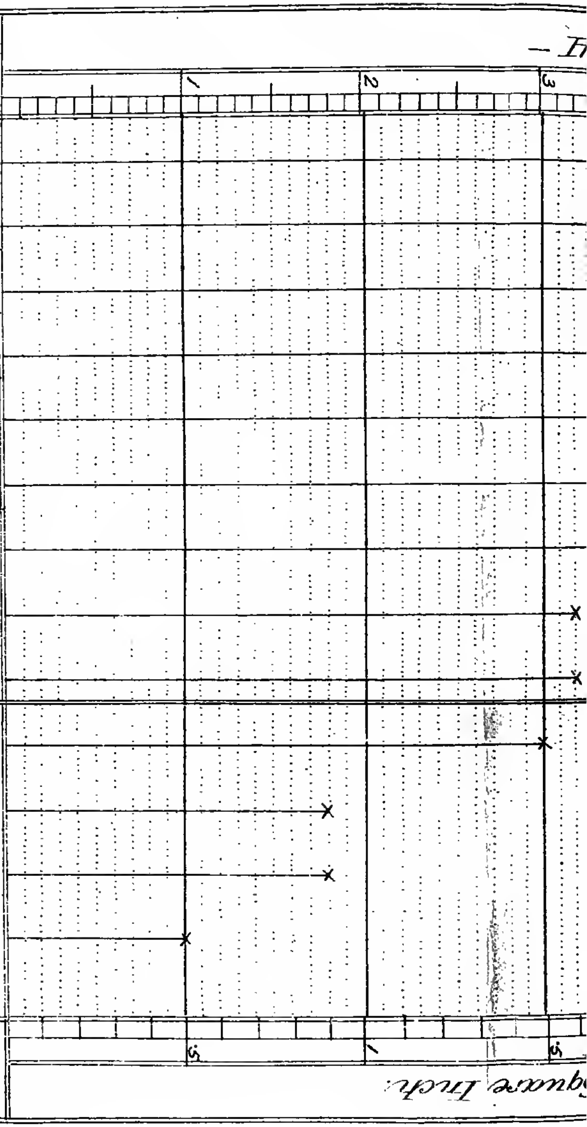
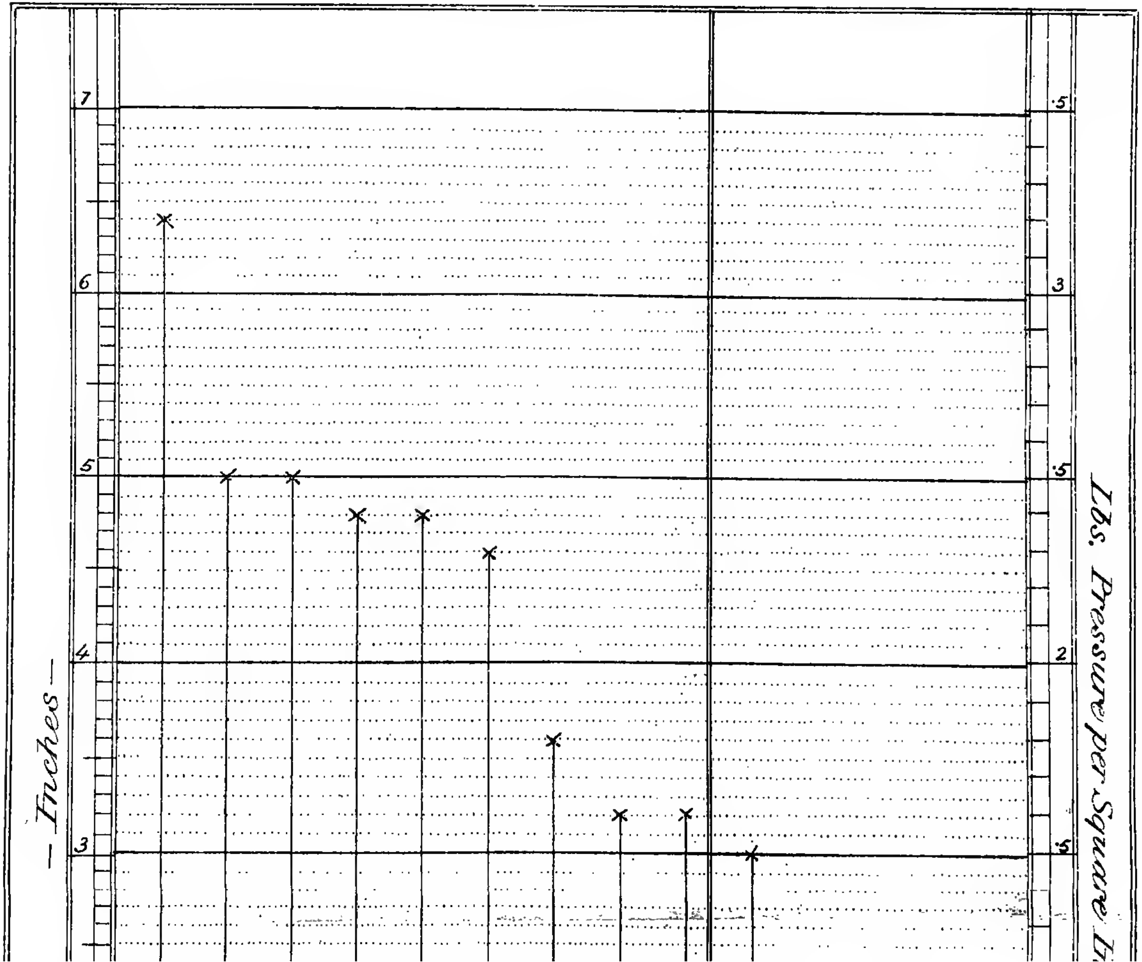
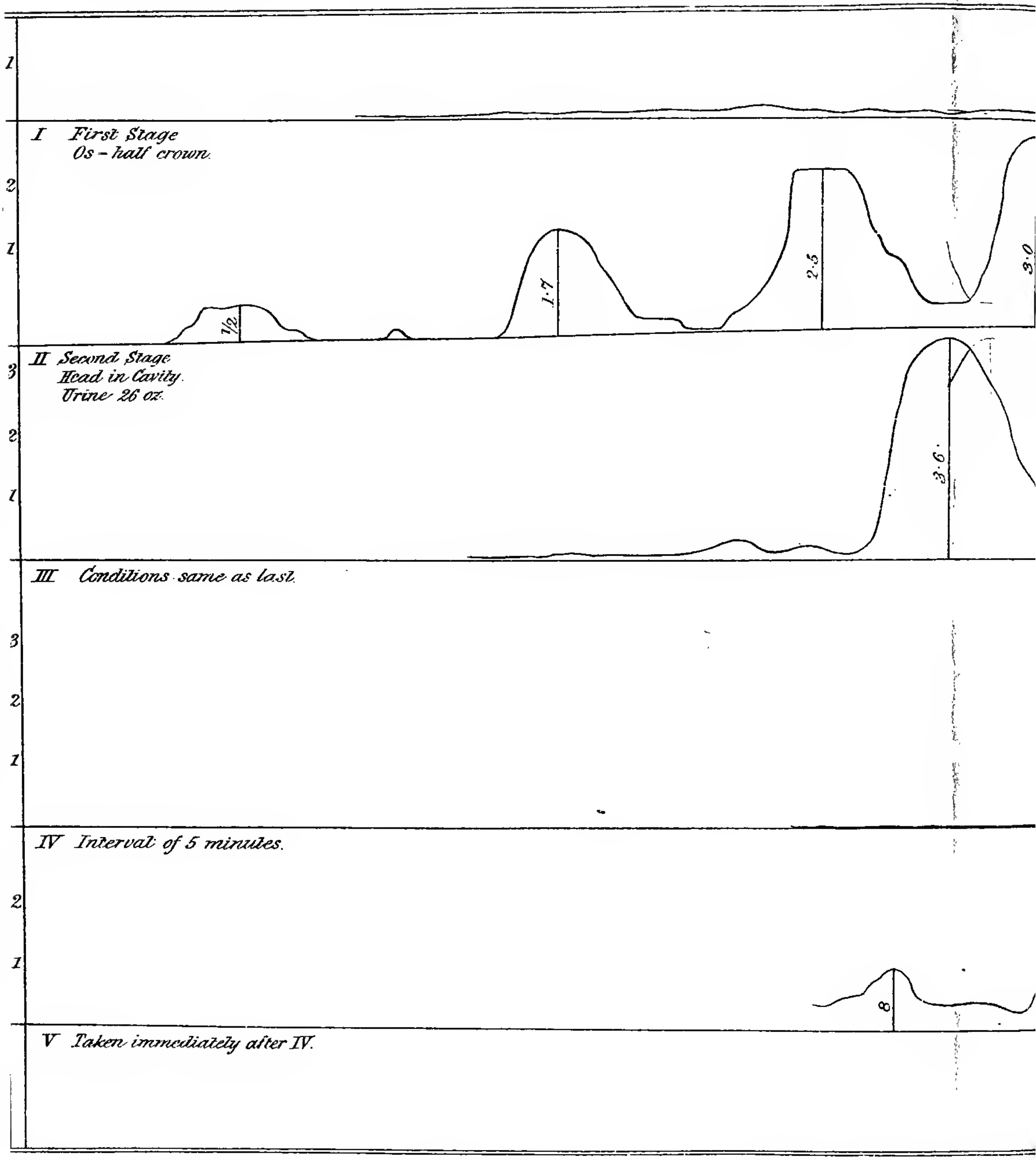


TABLE VIII.

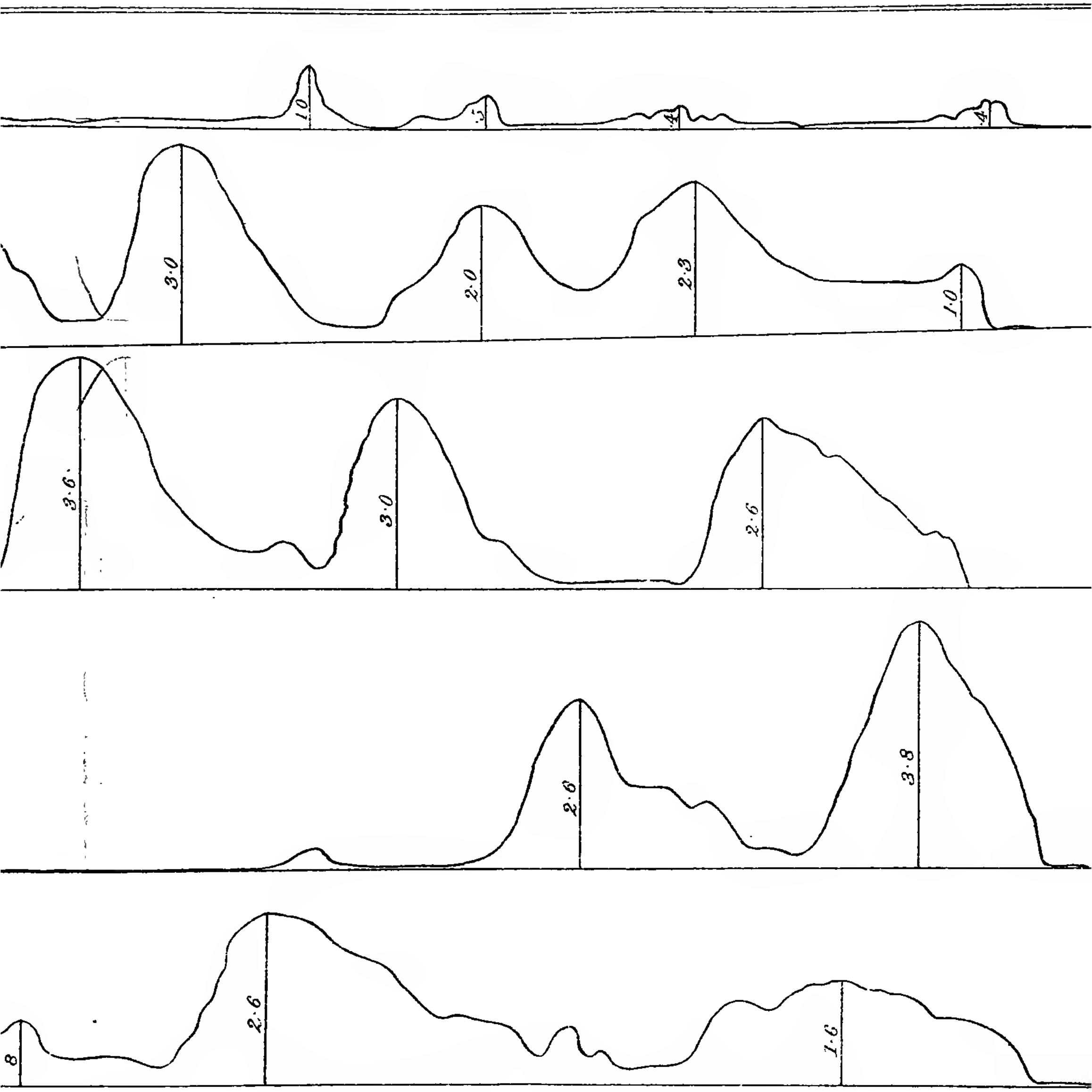
MANOMETRIC OBSERVATIONS ON THE BLADDER IN PARTURITION.

Showing Pressure per square Inch of Bladder Area.
C.- Multiparae-Dilated & Undilated.





E.K. primipara aet. 22.



ipara aet. 22.

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